CHEMICAL & METALLURGICAL ENGINEERING

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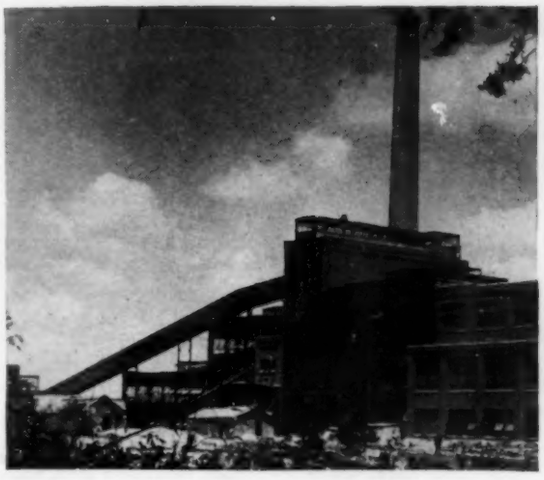

PULP & PAPER'S SOUTHERN TREK

ALMOST daily comes the announcement of new plants or plans for expanding existing pulp and paper operations in the Southern states. This is not surprising to chemical engineers because it fits logically into the program for the chemical development of the South which began in 1934 with the completion of the first large alkali plant. And it is likely to continue until well-rounded, diversified, chemical-consuming industry is under way.

First-hand observations as to what this development means to the South and to chemical engineers and executives in process industries elsewhere, will be found in an article in the December CHEM. & MET. by James A. Lee, managing editor, who has just returned from a 4,000-mile tour of this active area.

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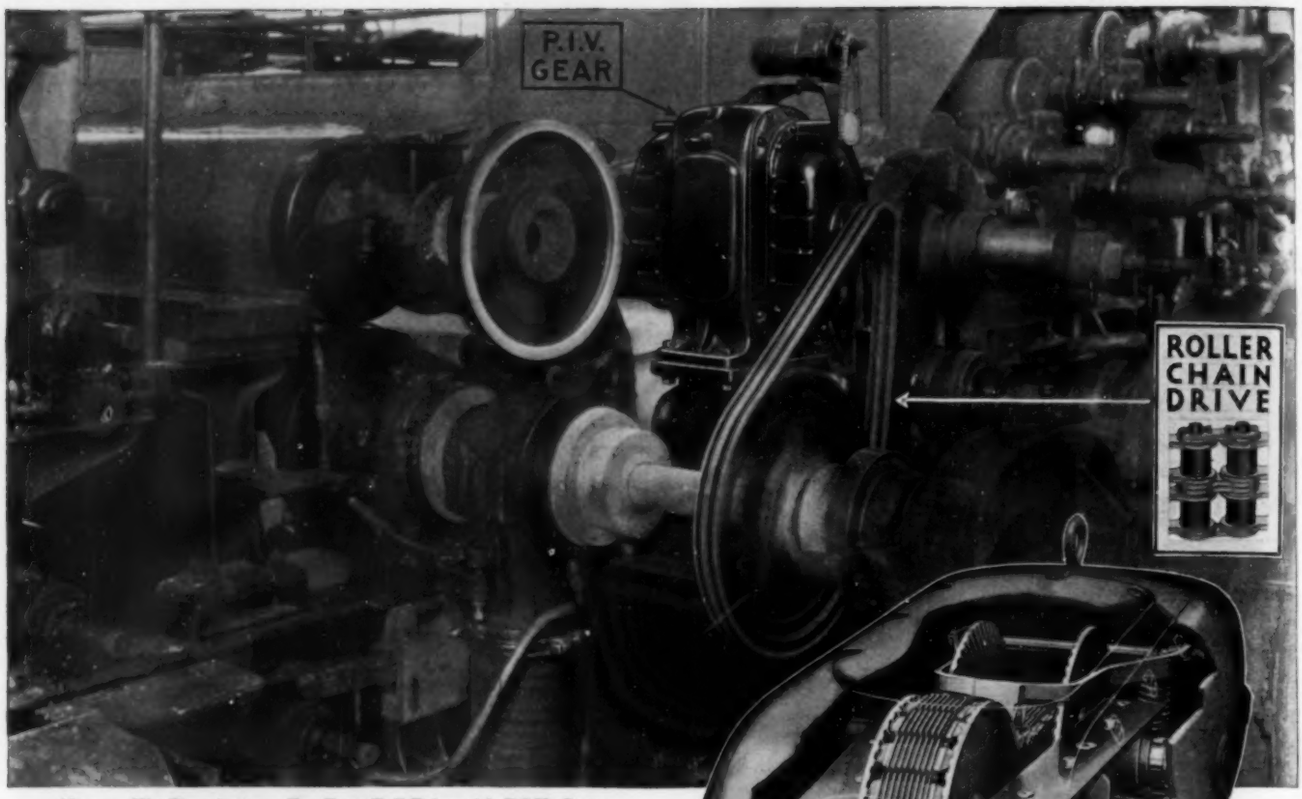

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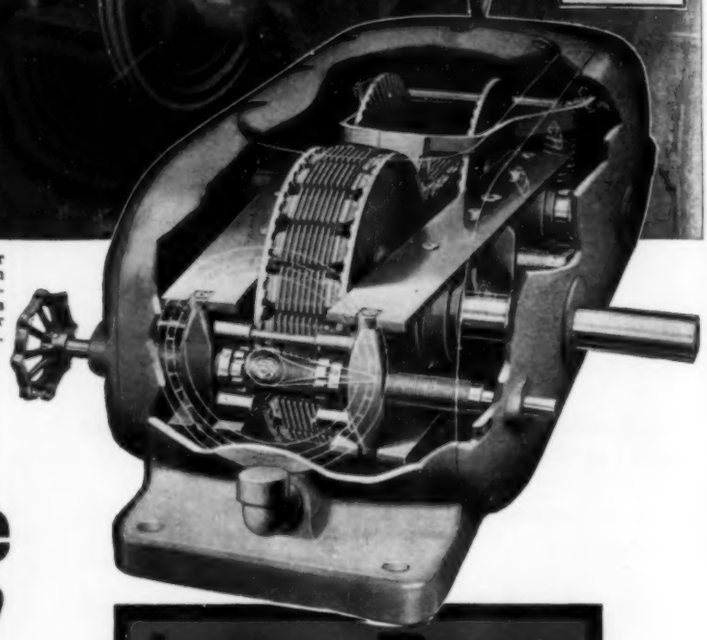

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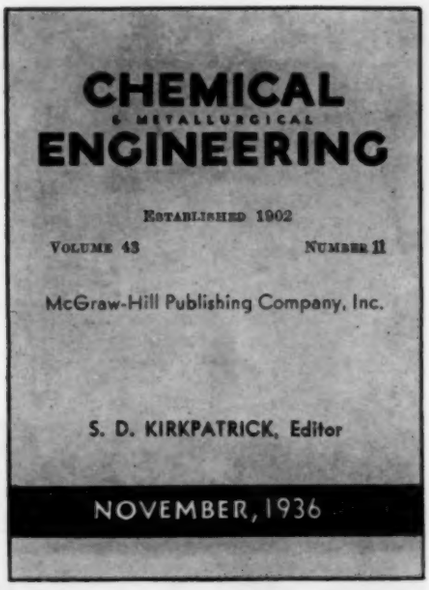


MUST CHEMICAL INDUSTRY BE COORDINATED?

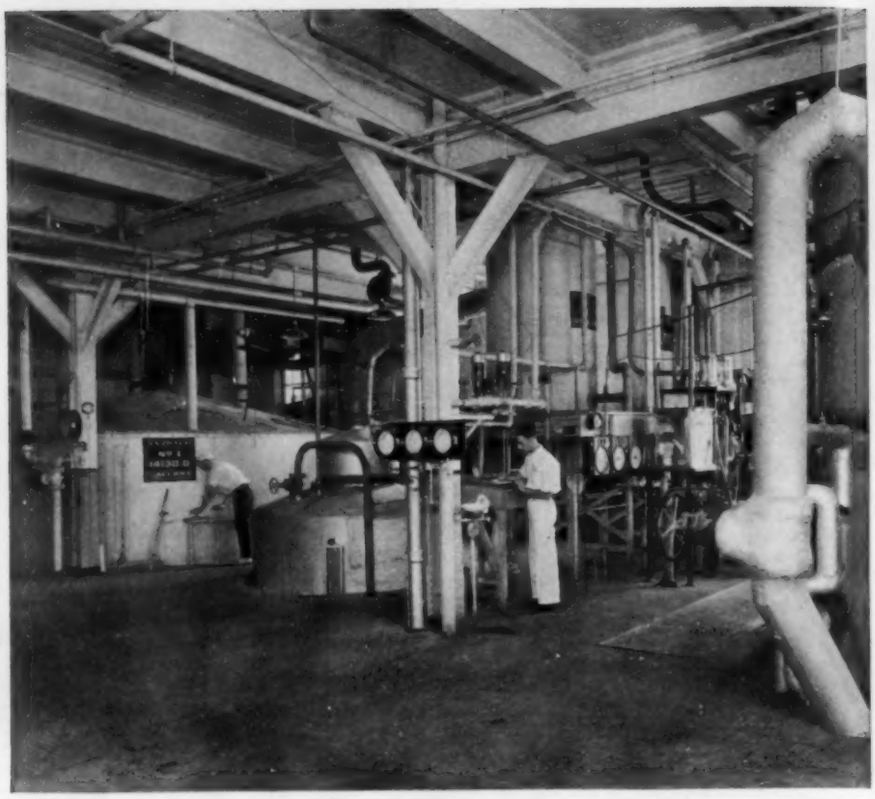
PURPOSELY, we waited until after election to publish this editorial, although it was written early in October. Our reason is that it deals with a certain malpractice in governmental administration in Washington which we hope will no longer be regarded as a political issue. We refer to the use by the "Coordinator for Industrial Cooperation" of the official statistics of the Census of Manufactures as the basis for a wholly unfair indictment of chemical industry.

The obvious purpose of this governmental activity is to incite the wage earner to turn against the employer and to demand a larger percentage of the value added by manufacture. Word has already come to us from far distant parts of the country showing how these reports are being used to promote organization and unionization by stirring up trouble and discontent among workers in chemical plants. With such objectives in mind it did not take a particularly clever statistician to distort the official census figures into showing that chemical industry is the lowest of all industrial groups in the percentage of the value added by manufacturing which is paid out in wages,—19.2 per cent in 1933 as compared with 36.2 per cent for all industry. No mention is made of the fact that the average annual wage for chemical industry in 1933 was $931 as compared with $869 for all industry. Nor does the report point out that due to the inherent nature of chemical manufacturing, labor is a much less important factor in the total cost than is true for other commodities. That technical supervision, heavy plant investment and rapid obsolescence are all proportionately higher seems to have escaped the "Coordinator."

Yet his report, "Group Summary: Chemicals and Allied Products," Vol. 1 No. 9, Sept. 12, 1936, would have the wage earner believe that he is entitled to an increase in pay directly proportional to his productivity as measured by the ratio of the number of workers to the total value added by manufacture. Using this hypothetical figure for his index, the "Coordinator" notes that in 1914 the chemical "wage earner's productivity was 77 per cent greater than that for all industry while his average wage was 4 per cent less, and the percentage added by manufacturing paid in wages was 45.8 per cent less than for all industry." Therefore, the "Coordinator" concludes that "if the (chemical) wage earner had received an average yearly wage comparable with his greater productivity (or 77 per cent greater), his wages would have increased 85 per cent over what he did receive." This can be true only when you reason from the false premise that labor alone was responsible for the tremendous increase in productivity in chemical industry. What about the contribution of salaried employees, of modern chemical engineering processes, plants and equipment?

There are many other fallacies in this report which any chemical engineer or executive will be quick to spot. But for the uninformed, who is willing to accept unchallenged its superficial air of impartiality, it can prove grossly misleading. We are convinced that its distortion of facts is too great to have been unintentional. We can only conclude, therefore, that it is a deliberate attempt on the part of a governmental agency to stir up class hatred and promote trouble and discontent.

FROM AN EDITORIAL VIEWPOINT



Fifty Full Years of Research

FEW INDUSTRIAL organizations anywhere can boast of fifty years of continuous emphasis on scientific research. As a matter of fact there may be some question in our minds as to just what constituted industrial research a half a century ago when Arthur D. Little and Roger B. Griffin established their historic partnership. But we are certain that no agency has contributed more constructively or has more courageously sponsored the idea that chemical engineering is synonymous with progress. That the founder and leader of this organization could not live to participate in this golden anniversary of research is greatly to be regretted by all members of the chemical profession. We join with them, however, in congratulating President Stevenson and those who carry on the great work of Arthur D. Little, Inc.

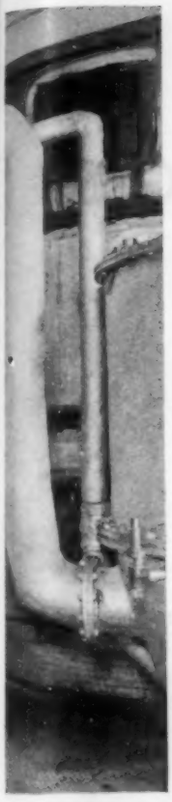
Chemurgy Covers the Country

CHEMURGY is a new word even though it does not stand for a new idea. By its recent spread to the South, to California and other parts of the country, it seems to have caught on, to be attracting real and deserved attention to the many problems involved in the non-food processing of agricultural materials.

Lately we have noted some evidence of competition for the credit of having started this movement. It is to be hoped that petty jealousies will not grow into an important factor. Results are needed. It is not really important who gets the credit for starting them.

Chemical engineers who know how to figure accurately and honestly the costs and the values of a new process must direct these developments. Agriculture, industry, and the public will all suffer from fallacious reasoning, erroneous planning, and over-optimistic investment. Mistakes will be costly to many beside those who lose money as a result of them.

There is a generous area available for development in the South. Nor is this confined entirely to pulp and paper, tung oil and other commodities most often mentioned. For example, we need more generous supplies of



fats from domestic raw materials. Non-edible, as well as edible, supplies should be studied and every effort should be made to determine how it may be possible to produce in the United States a substitute for those imported fats and oils now obtained from the coconut and other palm-family sources. Innumerable possibilities in plastics lie ahead. And the opportunity for making specialized synthetic derivatives of natural carbohydrates, from lignin, and from a score of other raw materials, is most encouraging as a chemical engineering prospect.

Agriculture is likely to be pampered unduly in Washington for the next few years. Industrial harangues and resentment will not offset this tendency very much. But an intensive development of industrialization starting from agricultural raw materials will be a successful means to offset the political leader who appoints himself as saviour of the farmer. And it is most likely that the farmer will welcome the industrialist in this role of processor even more than he has encouraged the politician with "relief." The task is not easy, but it is one well worth doing well.

The Long, Long Road

MORE THAN twelve years ago, in an historic series of articles in this journal, Dr. N. K. Chaney commented hopefully on certain patents that had just been issued to him as a result of his wartime work on activated carbons. Although these patents have been in almost continuous litigation since that time, the industry has pushed ahead in spite of this handicap of uncertainty. Recently an uncontested judgment in favor of these patents was confirmed by the Circuit of Appeals, and on Oct. 20, Federal Judge Barnes of the District Court in Chicago, handed down another most interesting decision validating U. S. Patents 1,497,543 and 1,497,544. Thus the end of the long, long road to validity, with all its costly and discouraging obstacles, is definitely in sight.

Accidents Won't Wait

DEATH has again taken its toll in the laboratory. This time the victim was a promising young chemical engineer who was just finishing five successful years of study in preparation for a place in the profession. But a career hardly yet begun was cut short because of failure to observe a few simple safety rules. The accident, which took place in the chemical engineering laboratory of one of our leading universities, was attributed to the student's neglect to flush a steel drum which had previously contained alcohol, before attempting to cut off the top with an acetylene torch. The drum exploded when the torch was applied, the flying mass partially decapitating the student. Two undergraduates who witnessed the accident learned a safety lesson they will never forget.

But is it necessary to view such a scene before we can learn the importance of safety rules? Chemical engineering involves certain inevitable hazards, and the sooner the beginner in the field can learn to apply common-sense safety principles where these hazards exist, the better it will be for both himself and his profession. We wonder how many schools lay as much stress on safety as on other phases of engineering training. Too often it is left almost entirely to the employer to educate his new charges in the principles of "safety first." Only recently a 1936 chemical engineering graduate, now employed in the plant of a large eastern chemical company, said, "I wonder why they never pounded this safety stuff into us back at school the way they do here?"

Safety education must start in college laboratories. It is there that industrial hazards are first encountered and it is there that the practice of safety must begin. Accidents won't wait.

With the Institute at the

WORLD'S LARGEST

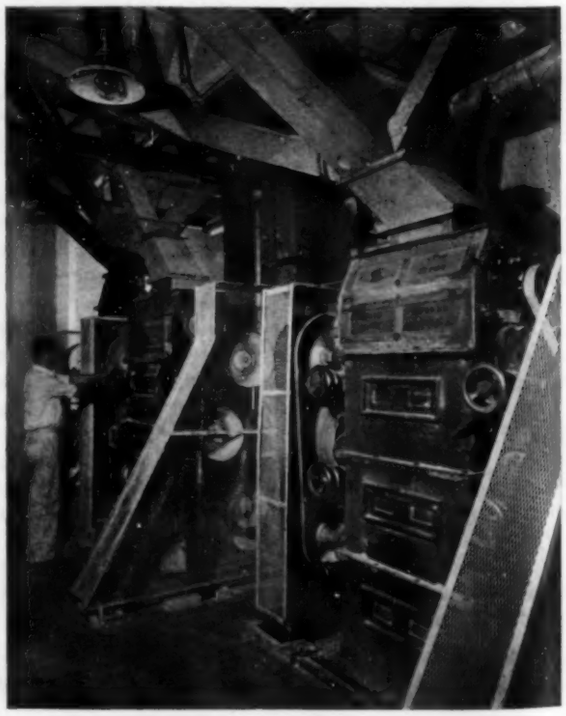
An important feature of the program offered to the American Institute of Chemical Engineers during its Baltimore meeting, was a visit to the rye distillery of the Calvert Distilling Company, at Relay, Md. So that those readers who did not take part in the inspection could still, in effect, "visit" this modern plant, a *Chem. & Met.* editor preceded the engineers, recording below what he saw.

WHEN Prohibition was repealed three years ago, one company that was ready and waiting to do its part in curing the Great American Thirst was the Maryland Distillery, Inc., which forthwith set about building the nucleus of what is today the world's largest distillery devoted exclusively to rye whiskey. Having acquired the Calvert Distilling Co., the merged company was itself merged in 1934 with the Distillers Corporation, Ltd., of Canada, so that today it is, like the Seagram organizations of the United States and Canada, an important link in the tremendous chain forged together as Distillers Corporation-Seagrams, Limited.

The plant is built on a site a few miles south of Baltimore with direct rail connection to the Baltimore & Ohio R.R. Physically, it is impressive, occupying a tract more than a quarter-mile in length, with 18 major and several minor buildings, covering an area of about 18 acres. Most notable in the general panorama are the five rack houses—bonded warehouses with a capacity of 256,000 bbl. in which all the whiskey made in the plant is stored for a period of four years, or more. These building aggregate over 15 acres of floor space. In them the charred white oak whiskey barrels are racked three or six high per floor, depending on the type of building.

Possibly the chemical engineering features of the plant are less impressive, but they are none the less interesting. Among them should be mentioned the close quality control exercised at every point in the process from grain purchase to blending and bottling and the liberal application of recorders and automatic regulators that is evident on the equipment.

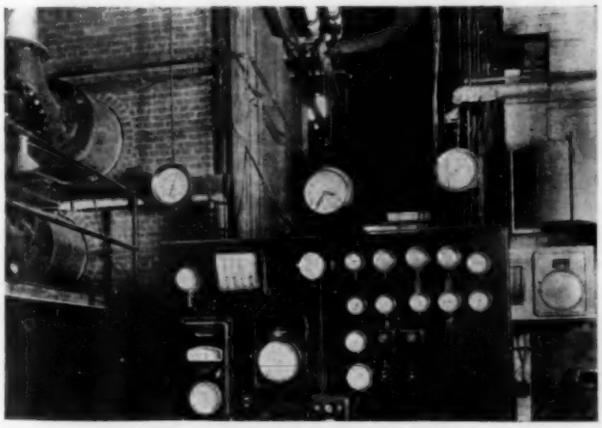
Perhaps the most effective way of viewing the plant will be to follow through the various stages of the process, step by step. Rye (which comes generally from Poland or Latvia) together with barley malt, bottles, cartons and fuel are received on one or the other of three railroad sidings running through the plant grounds. (It is an unfortunate fact that owing to poor quality, only small quantities of domestic grain rye can be used.) The grain and malt are unloaded at a 25,000 bu. storage elevator, adjacent to the fermentation and still buildings, by means of an electric screw conveyor capable of moving 1,000 bu. per hour. These materials are lifted mechanically to the topmost floor where they are first passed over scales, then cleaned thoroughly, and the screenings, averaging about 2 per cent, discarded and removed from the plant. From the storage hoppers, both rye and malt descend over magnetic separators into 130-bu. per hour roller mills of the three-pair-high type. Two mills are employed for grain, one for malt. Constant supervision in milling is necessary to secure the desired character of granulation—a maximum exposure of the starch grains without production of flour. Elevators lift the milled products to weigh hoppers at the top of the still building, ready for delivery, at the plant capacity rate of 4,085 bu. per day, to the mashing equipment.



Here the grain is granulated in three-pair-high roller mills

RYE DISTILLERY

Eight bottling lines in the Calvert Distillery have a total capacity of 14,000 cases per day



Three tubular boilers, rated at 130,000 lb. per hour evaporation, supply the plant steam load

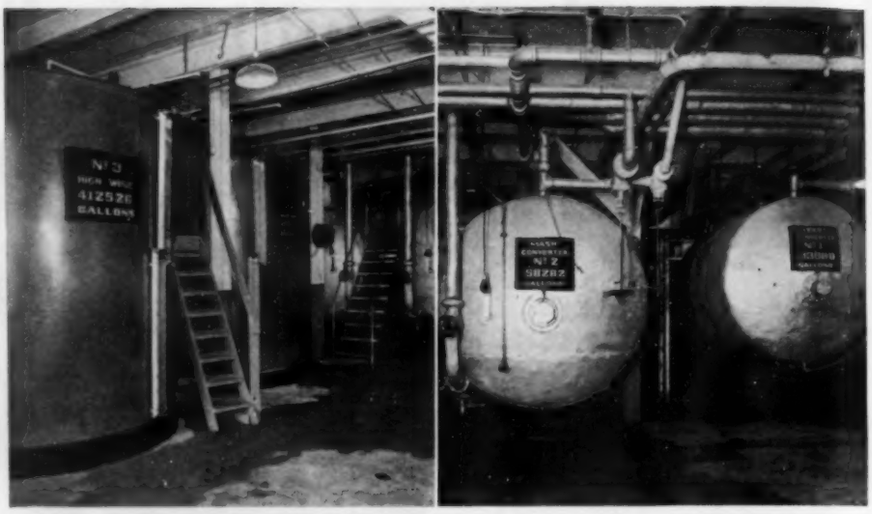
At this point, it will be desirable to digress long enough to mention two auxiliary services that are extremely important in a distillery: water and steam. Five deep wells are pumped to supply the company's 1½ million gallon reservoir, and the flow of a spring-fed stream has recently been tapped to complete the requirements. Before it enters the plant, the water is passed through a coagulating flume where it can be treated with alum if required. It is then aerated for iron removal, passed through a settling basin and inclosed sand filters, handling 900-1,200 g.p.m., and finally chlorinated. All of the plant's water with the exception of a small part of that required for cooling purposes is so treated. Boiler make-up, which constitutes some 70 per cent of the boiler feed, is treated in an 8,000 g.p.h. hot process lime-soda softener. All water required for reducing the strength of the final still product to standard proof for bonding is produced in a 1,300 g.p.d. steam-heated copper water still.

The boiler house is equipped with three tubular boilers, one of 800 and two of 250 hp. rated capacity, totaling 130,000 lb. per hour evaporation. The smaller boilers, which generate at 250 lb., are oil-fired while the larger, generating at 375 lb., may be fired either with oil or pulverized coal. About a third of the plant's electric power requirement is supplied through a turbo-generator exhausting to the low pressure steam mains at 17-20 lb. The remainder of the process steam and heating load is provided by boiler steam passed through pressure reducing valves.

Returning to the plant operations proper, we find concentrated in the still house and adjoining fermenter house most of the actual manufacturing of the distillery. Under government supervision the milled rye and malt are weighed into batches containing about 15 per cent malt and 85 per cent rye and dropped into warm water contained in the mashing equipment. This equipment includes a 14,000 gal. mash tub and two 5,800 gal. mash converters, the former a vertical agitated tank supplied with a perforated steam coil, and the latter horizontal steel tanks with horizontal paddles and a number of live steam connections. A charge for the tub consists of 12,637 lb. of rye and 1,941 lb. of barley malt, and for the converters, 60 per cent of this quantity, with about 22 gal. of warm condenser water for each bushel of grain. In mashing, the mixture is quickly heated with steam to 150 deg. F. and held at this temperature for an hour. During this operation the diastase of the malt acts on the starch of the grain, liquefying it and converting it into the fermentable sugars, dextrine and maltose. At the completion of the holding period, the saccharified mixture is discharged to a drop tank and then pumped through a double-pipe cooler where it is lowered in temperature to 80 deg. F. before passing into one of the 15 large fermenters. The total mash tub cycle is about two hours. Three mash tub charges, or five converter charges, constitute the quantity required to fill a single fermenter.

The only raw material not so far considered is the yeast which, aided by a catalytic enzyme, zymase, given off by it, serves to convert the sugars of the mash into alcohol and carbon dioxide. Propagating the yeast is one of the most critical steps in distilling, calling for the

use of a selected pure culture yeast which is grown carefully under the most suitable conditions. The culture is started in the laboratory, using a malt extract as a culture medium. After sufficient growth, it is transferred to the plant where, in the "dona room" its growth is continued in four small tinned copper vessels equipped with cooling water jackets. At the end of a suitable interval it is again transferred to four 3,000 gal. tinned copper-bearing-steel tanks. Finally, some 35 hours after it has left the laboratory, the yeast has grown to a point where it can be used for inoculating the fermenters. A single small converter, similar to the two larger ones used for mashing, is provided for preparing the yeast mash employed in these growing operations. Half barley malt and half rye malt is used for this purpose.



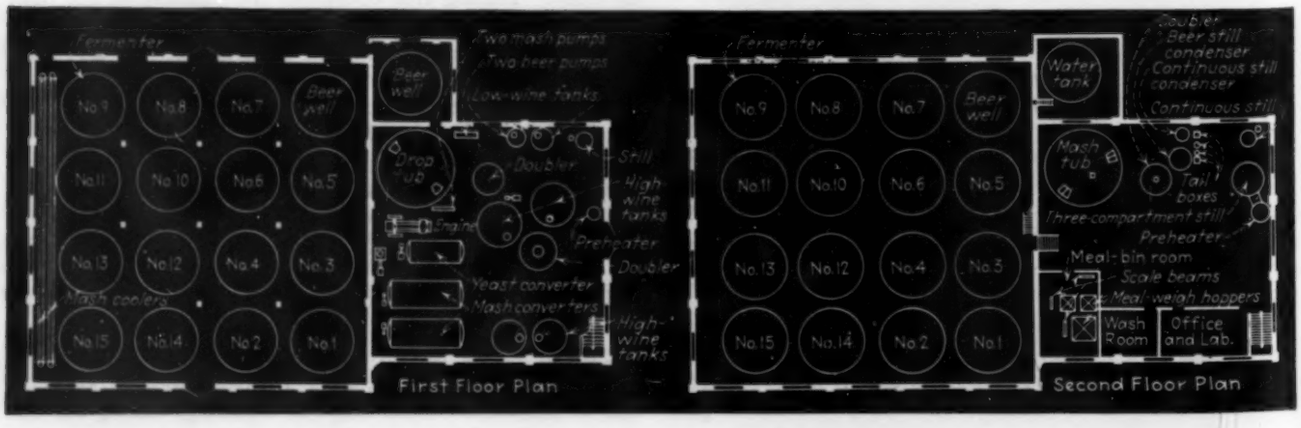
Part of the first floor of the still house showing high wine tanks, mash converters and yeast converter; a general view of the second floor, on which is the mash tub and distillation equipment, will be found on page 574

Fermentation of the mash takes place in 15 40,000-gal. open fermenters, constructed of copper-bearing steel and coated internally with a vegetable-base paint. Each fermenter is provided with a perforated air pipe, a cooling coil and a live steam connection for sterilizing. Five fermenters are started each day, the cooled mash being run in, diluted with water to about 35 gal. per bushel, and the yeast added. After 48 hours, when the alcohol content has reached about 9 per cent, the contents of each fermenter, now called "beer," is dropped to one of two beer wells, ready to be pumped over the stills. Believing that the best product is obtained in open fermenters, the company does not attempt to recover carbon dioxide.

Two stills are provided, one a three-chamber charge whiskey still and the other a continuous beer still. The three-chamber type, although it is somewhat less efficient thermally than the other, is generally considered to give a better product, particularly where a heavier body rye whiskey is desired. It contains four chambers, one over the other, the top one serving only as a beer heater. Each of the lower chambers has its vapor space connected to vapor pipes discharging beneath the surface of the beer in the chamber above, while the bottom chamber is equipped with an external heater provided with 198 2-in. tubes and heated with both exhaust and live steam. Operation of this still is as follows: every 17 minutes a charge of 1,900 gal. of beer is admitted to the top compartment while, at the same time, the previous charges are each dropped one compartment. Thus, each charge is boiled three times, the third time—when it is nearly dealcoholized—with steam, and the first and second times by the ascending vapors. From the third compartment, vapors pass to the condenser, while from the bottom, the exhausted slop is drained to a storage tank, pending recovery of the spent grains. This still produces 140 wine gal. of high wines and 70 gal. of low wines per charge. The high wines, draining to suitable high wine tanks on the floor below, are later redistilled in a doubler, while the low wines, containing the bulk of the undesirable congenerics, are later returned to the still with the beer feed.

The continuous still is of the usual type, with bubble caps in the upper chambers, and perforated plates in the lower. At its capacity of 4,000 gal. of beer per hour, its

First and second floor plans of fermentation and still buildings showing principal equipment

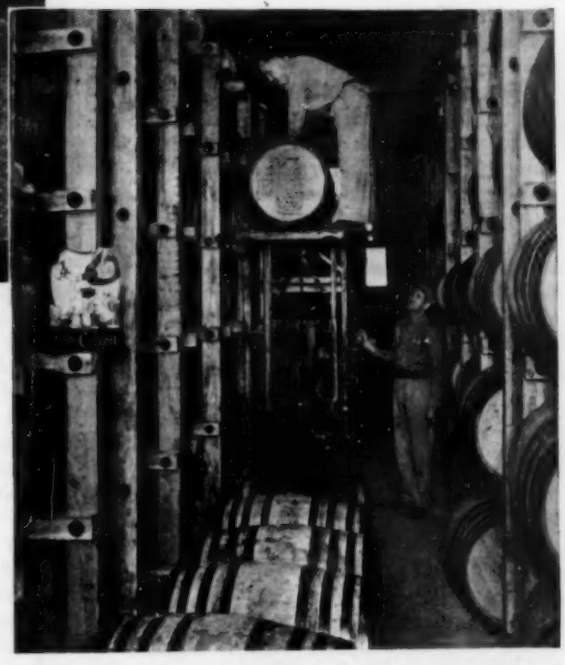


hourly output is 375 wine gal. of high wines, ready for the doubler. This latter piece of equipment, of which the plant has two, is a simple pot still consisting of a copper body heated with a steam coil and connected by a tall vapor pipe with a condenser. The output of the doublers goes to the cistern house at a concentration of 112-115 proof where it is held in one of four 11,750-gal. copper tanks until it has been reduced with distilled water to 103 proof, the concentration at which it is bonded. The reduced whiskey is then run into internally charred white oak barrels which are transported to the several rack houses, there to be matured for the bonding period, or longer.

One indispensable phase of modern distillery practice is the efficient recovery of the spent grains for cattle feed. The dealcoholized slop from the stills is allowed to settle and the clear liquor decanted and pumped to a triple-effect evaporator where it is concentrated to a syrup containing about 25 per cent solids. The settled solids, on the other hand, are first partially dewatered on a rotating copper screen, followed by a traveling-screen-bed press, then dried in a series of steam-heated rotary dryers. Of the four dryers used, the first two are fed in parallel with each other, but in series with the remaining two. Syrup from the evaporators is added to the partially dried grains in the screw conveyors connecting the discharge end of each dryer with the feed end of the next one. By this combination of drying and evaporation, then, the 92 per cent initial moisture of the slop is reduced to 5 per cent in the finished product, which is elevated to a packing floor and bagged for sale and shipment. Although this recovery has as its primary purpose removal of an otherwise troublesome waste material, it yields in the neighborhood of 11 lb. of feed per bushel of grain mashed, and proves to be a profitable operation.

All that remains of our plant visit is to describe briefly the blending and bottling operations carried out in two of the larger buildings. Since none of the whiskey made at the plant has at the present attained sufficient age, all that is now passing through these final departments is obtained from affiliated companies. Various whiskies brought into the blending or "rectifying" department are combined either with each other or with neutral spirits, by methods which can only be described as an art, to produce blends developing to the maximum degree certain desirable characteristics. The blends, or if desired, certain straight whiskies, are then pumped to elevated filling tanks and piped down through pulp filters to the bottling machines. Here, in a highly mechanized department, on eight conveyorized bottling lines, the various grades acquire bottles, caps, labels, revenue stamps, and cartons—meanwhile being constantly inspected every step of the procedure. As a final safeguard, each case is weighed and stamped with its weight for protection against possible shortage, then dropped through a chute to the shipping department on its way to the American public.

One of the 15 40,000-gal. fermenters at its stage of greatest activity



Mechanical handling simplifies utilizing the 256,000-bbl. capacity of the five rack houses

In conclusion, we wish to acknowledge the kind assistance of various individuals, including Dr. H. E. Bacon, Jr., an associate of Sheppard T. Powell, consulting engineer of the distillery; and among the distillery personnel, of E. M. Fleischmann, president, J. O. Herrmann, vice-president, D. Garlock, superintendent and plant engineer, and E. F. Zepp, chief engineer. To all of these gentlemen thanks are due both for their aid in securing the necessary information for this article and in checking its final accuracy.

Chemical Engineers Study Baltimore Plants and Problems

EDITORIAL STAFF REPORT

Editor's Note: As this issue goes to press, the twenty-ninth annual meeting of the American Institute of Chemical Engineers is being held in Baltimore, Md. Abstracts of such papers as were available in advance of the technical sessions are presented here. Others will be included in a more comprehensive report in the December issue.

WITH Past-President Albert E. Marshall as its honorary chairman, an active local committee headed by Sheppard T. Powell planned unusual arrangements for welcoming the return of the American Institute of Chemical Engineers to Baltimore, Md., after an interval of 15 years. Plant inspection trips were arranged for all of the chemical engineers and their guests to visit the huge rye whiskey distillery of the Calvert-Maryland Distilling Co. at Relay, Md. (see pages 576-9 of this issue), the adjoining plants at Curtis Bay of the U. S. Industrial Alcohol Co. and its chemical company subsidiary. Optional trips were offered to the Maryland Glass Corp., the Fairfield Western-Maryland Dairy, and to the city gas and water filtration plants. In the three technical sessions on applied chemical engineering, several of the papers[1] dealt with problems in distilling industry, petroleum refining, and fields of major industrial interest in Baltimore. Abstracts of such papers as were available to the press in advance of the meeting follow:

Cracking Petroleum. Prof. D. B. Keyes, head of chemical engineering at the University of Illinois, selects the process of cracking as an example of a unit process of chemical engineering and contrasts it with the more familiar unit operations—all for the purpose of driving home to his students the necessity for a working knowledge of the fundamentals underlying design, construction and operation. He points out that while very little is actually known about the mechanism of cracking, it is affected primarily by the factors of temperature and time—secondarily by pressure.

Modern systems, in general, subject the entire mass of oil to cracking but carry the process only a part of the way toward completion, following this by separating the gasoline and the tar from the unchanged oil, which is then returned to the cracking unit. Conditions may be so regulated that gasoline of high volatility and high anti-knock rating may be obtained without undue loss in yield or coke formation. Pressure serves to create more liquid at the expense of vapor and thus increases the average density of the contents of the cracking unit. Heavier tars are held in suspension and are prevented from adhering to the heated walls and thus forming coke.

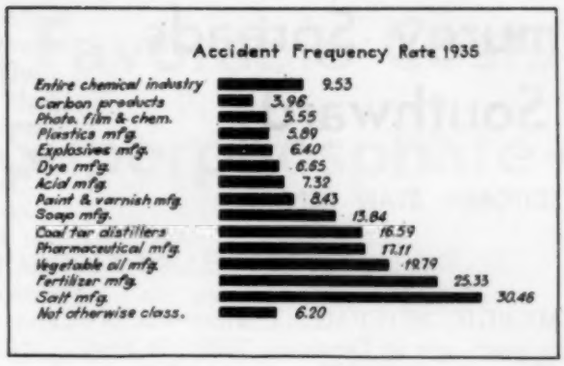
Heater Design. Roy Lyster, chief engineer of the Alcorn Combustion Co. of Philadelphia, described the development of modern heating practice in petroleum refining. The principal problem of the designer, he said, is "so to construct an oil heater that no tubes are raised to temperatures above their safe operating range but at the same time he must maintain the highest average range of heat input compatible with the maximum safe operating temperature." This means that the design must avoid "hot spots," i.e., prevent both the overheating of the first tubes, which are directly exposed to the path of flame and the under-heating or "loafing" of the tubes in the back of the furnace. In one modern type of furnace this problem has been solved by introducing the burning of the fuel (either oil or gas) through muffles or tunnels made of special heat-resisting refractory. The hot muffles liberate heat by radiation to the oil tubes in the roof of the furnace, while the hot combustion gases, which have lost most of their radiant heat, pass forward over the floor tubes to the bridge wall, thence over its top and downward through another section of tubes on their way to the stack. Such a furnace will show a thermal efficiency of about 67 per cent as compared with 30 to 50 per cent efficiency on the early stills used by the oil industry. While the older units operated at average heat transfer rates of about 1,500 to 3,000 B.t.u. per sq.ft., the overall heat input rate in a modern gas oil cracking heater will be about 10,000 B.t.u. per square foot.

The problem of providing suitable construction materials led the metallurgists of the petroleum industry to extensive experimentation with various chromium and chromium nickel alloys. The material that seems best to meet the industry's severe requirements is an alloy containing 4 to 6 per cent of chromium with ½ per cent of molybdenum. The latter element greatly increases the strength at high temperatures, permitting safe operations under most efficient conditions.

New Refining Methods. The possibility of using sulphur monochloride as a polymerizing agent in the refining of hydrocarbons was set forth in the report of an investigation by W. A. Patrick, D. G. Zink, and H. R. Jones, of Johns Hopkins University. Accurate experimental measurements were made of reaction rates between sulphur monochloride and saturated aliphatic hydrocarbons in the presence of various unsaturated aliphatic, aromatic and cyclic hydrocarbons—a combination commonly found in the higher light oil fractions. The measurements indicated that there is enough difference between the rate of reaction with certain unsaturated compounds and the rate of reaction with saturated compounds to render the action selective. From these results, it is concluded that small amounts of sulphur monochloride can be used to wash out the undesirable constituents of light oils. The fact that sulphur monochloride is very soluble in hydrocarbons further encourages this belief, for this means that the action of the reagent may be

[1] Prof. N. W. Krase's paper on "Carbon Monoxide as a Raw Material for Chemical Synthesis" appears on pages 590-5 of this issue.

tempered by diluting it. Therefore, there is a possibility of adding the reagent in such a manner and in such quantity that the undesirable hydrocarbons and mercaptans will be attacked and either be destroyed or rendered unobjectionable, while the desirable unsaturated and saturated hydrocarbons will remain unaffected. The data indicate that the action on mercaptans, thiopene and substituted thiophenes is very rapid at 76 deg. C. The report also shows that the rate of reaction with unsaturated hydrocarbons increases with the molecular weight of the hydrocarbons.



Economics of Safety. Reuel C. Stratton, supervising chemical engineer, Travelers Insurance Co., Hartford, Conn., reported that during the ten years 1926 to 1935 inclusive, the frequency of accidents in the chemical industry decreased 54 per cent and the severity of accidents as measured by working days lost, decreased 51 per cent. These figures, which are based on published reports of the National Safety Council, represent the consolidated experience of 282 factories.

Contrary to popular opinion, chemical industry is by no means a particularly dangerous industry; in fact chemical industry ranks tenth among all industries in accident frequency and in accident severity. Moreover, the business of making explosives, dyes, and acids is far safer than is the business of making paint and varnish, soap, fertilizers and salt. The reason is that chemical processes even though of great potential danger can be put under complete control by proper engineering methods. Only 13.5 per cent of accidents in chemical industry is caused by contact with chemicals; 26 per cent is caused by handling objects, such as barrels and cases; 18 per cent is caused by falls; and 11 per cent by machinery.

Distillery Advances. Chemical engineering and allied sciences are gradually supplanting the old-fashioned distillery methods according to C. S. Boruff, technical director and L. P. Weiner, superintendent, of Hiram Walker & Sons, Inc., of Peoria, Ill. However, rule-of-thumb traditions die hard, and in recent years various distillers have advertised that they make the same kind of whiskey that was turned out in 1850. This is scarcely something of which to boast, since the typical old-time distiller used grain of poor quality, insanitary methods and crude, inefficient equipment. And the worse the whiskey, the longer the aging had to be!

Research in the old days was unknown, and only a beginning is being made today by the proponents of science. Boruff and Weiner said, in part:

> We find in the United States far too few distilleries that have a progressive and modern production attitude, modern equipment, a plant that will bear sanitary inspection and that operates under the proper balance of "technical control." * * * In the "Good Old Days" there seemed to be a myth among some people in the industry that any kind of grain was good enough for the production of whiskey or spirits. Good distillery operations now demand corn at least two grades higher than that formerly known as "distillers' grade."
>
> The old-fashioned and common production method today is for each distillery to make one or two whiskies and use these same distilleries for all ages of whiskies. When sufficient stocks are available the distiller increases the age—the product eventually becoming a "Bonded Whiskey."
>
> Designing and producing predetermined whiskies that are clean, mellow, balanced, and mature at ages ranging from three months to six years, is a reality in a modern plant. All this has been accomplished through exhaustive studies of all variables and by putting all processes under strict control. No artificial aging methods have been found that even approximate the accomplishments that can be obtained by merely controlling the "natural processes."

Flash Evaporation. A thermodynamic study of the flash evaporation of potassium sulphate liquor from polyhalite, which has been carried out cooperatively by the U. S. Bureau of Mines at Pittsburgh and the Department of Chemical Engineering of Ohio State University at Columbus, was reported by Partridge, Fieldner, Withrow and their associates. The method studied was to flash the very hot saturated solution suddenly into a low-pressure area. Evaporation takes place very rapidly, the liquid being flashed into vapor and removed from the desired potassium sulphate. No heat is added or removed during the evaporation. Complete thermal analysis yields data on the heats of dilution and solution, vapor pressure and heat of evaporation of the water from the saturated solution. The authors set up a specific problem and draw a heat balance showing the quantity of heat which was put in with the solution and the quantity accounted for in the steam and in the final solution.

Ultra-Slow-Motion Photography. Newly developed high-speed cameras, capable of taking up to 3000 pictures per second, offer possibilities for the obtaining of valuable information in the design of chemical engineering equipment, according to Gustavus J. Esselen and John G. Hildebrand, Jr., of Gustavus J. Esselen, Inc. An "ultra-slow-motion" movie made of the currents set up by different types of high-speed stirrers in water, enables the eye to follow the stirrer as well as the path of an injected stream of colored water and so see exactly what kind of a mixing action is obtained with each stirrer. Other such studies have been made showing distortion of machine parts while moving at high speeds, the shapes taken by falling drops of water, what happens when an air stream is passed through water, and the movement given to a smoke stream by different types of electric fans. These suggest numerous further possibilities which might include studies of such things as characteristics of liquids in various forms of motion, mechanism of inter-phase actions, and the nature of the breaking process in such materials as metals, concrete, glass and plastics.

Other Papers. Papers not yet available for abstracting include the one by Arthur Wright of Goslin-Birmingham Mfg. Co. on "Chemical Engineering Phases of Filtration," another by Elliott J. Roberts and John V. N. Dorr of the Dorr Co. on "Sedimentation" and a third by S. T. Powell and H. E. Bacon, Jr., consulting engineers of Baltimore, and G. McChesney and Frank Henry of the Rochester Gas & Electric Co., Rochester, N. Y., entitled "Design and Development of Apparatus for Measurement of Steam Quality by Electrical Conductivity Methods."

Chemurgy Spreads Southward

EDITORIAL STAFF REPORT

THE CHEMURGIC MOVEMENT which was organized two years ago at Dearborn, Mich., is now spreading to other sections of this country. A three-day conference was held recently in Louisiana and another is scheduled for California on November 20. The recent meeting was backed by the sugar, tung oil, cotton, naval stores, rice and other southern farm organizations, which are interested in securing new uses for their products.

"Chemurgy got its start long ago. The momentum which has grown slowly, we seek to accelerate, "Wheeler McMillen, editor of *The Country Home,* stated. Its great achievement lies in the new thinking it has stimulated. New hope for the country's future has been generated because agriculture no longer is blankly confronted with a dismal prospect of forever producing unwanted and unprofitable surpluses. No other magic than the magic of hard thinking, hard study, and hard work is offered but that is the kind of magic that produces the most astonishing miracles.

"As rapid progress is being made in developing the chemurgic program as the scientific world has made in accepting the challenge of the new science," Dr. H. E. Barnard, director of research of the Farm Chemurgic Council, stated. And nowhere has that progress been more marked than in the South. Perhaps the need for a chemurgic program was greater here than in a more fully industrialized North. In any event here is found an enthusiasm for development and an appreciation of chemurgic possibilities which in a single year has reached very large proportions.

Alcohol From Cane

"There may be some in the audience here today," Dr. W. L. Owen, consulting bacteriologist, said, "who will have looked beyond the horizon of the realization of the chemurgic program in the development of a 1,600,000,000 gal. 'agricrude alcohol' industry for motor fuel, and they will be asking 'will that be all?'

"I may assure them that it is but the beginning, and remind them that chemurgy is seeking first the kingdom of practical and easily attainable, and leaving the other steps to the future.

"Chemurgy seeks first the outlet for these enormous tonnages of chemicals which our crop surplusages and wastes can be made to produce. It seeks first to establish alcohol, for motor fuel, rather than gluconic acid from corn or molasses.

"For the sugar industry ethanol is just a beginning, for just as easily as we can convert the carbohydrates of our molasses, and the juices from the cane tops, into ethyl alcohol, we can convert them into a variety of chemicals by biochemical processes.

"Acetone and butanol, of which our industries are now consuming 49,000,000 lb. annually, can be, and are being made from molasses under the Arroyo patents, with a yield of 34 per cent of the sugars present or, approximately 2.4 lb. per gal. of molasses, or about 20 cents from one gallon of raw material.

"Butyric acid can be produced from molasses or cane juice at yields as high as 43 per cent on the weight of the sugars, and at a cost of approximately 7c. per lb., and has a market value of 22 at the present time. A cheap source of this acid would undoubtedly greatly increase our present industrial utilization of this product.

"Citric acid of which we at one time were importing as much as $3,000,000 worth, we are now obtaining chiefly from Hawaii. It can be manufactured from molasses and bagasse by the Cahn process, with yields of as high as 17 per cent on the weight of the molasses, or at present prices, of 29c. per lb., at a value of 58c. per gal. of blackstrap. Undoubtedly a cheaper source of this acid will greatly enhance its usages, which are at present for flavoring extracts, confectionery and soft drinks."

Bagasse as Raw Material

"The economic advantages of bagasse as a raw material for industrial operations are so obvious that for many years continuous efforts have been made to find a use for the material other than as a rather low grade fuel," Fergus A. Irvine, technical director of the Celotex Corp., told the group. In recent years, the results of more intensive work in various directions have shown great promise and it is to be expected that the next few years will mark the beginning of several new enterprises dependent on bagasse as a raw material.

During the past 15 years, however, an entirely new industry, which employs bagasse as raw material, has grown to maturity. This industry is the manufacture of structural insulation. It is quite interesting to note that this important and highly successful commercial use of bagasse resulted not from researches directed toward the utilization of bagasse as a waste fiber, but from a search to find the most suitable raw material for a definite purpose.

New Southern Chemical Plants

In view of the truly wonderful combination of fuel, power, labor, raw material resources, climatic condition and other advantages, it is not surprising that the South is rapidly becoming a great chemical area," according to James A. Lee, managing editor of *Chemical & Metallurgical Engineering.* In 1914, 22 per cent of the entire industry was located in the South and by 1933 it had been increased to about 30 per cent. Since that time several things have happened to bring about greatly increased growth in the Southern chemical industry. The almost unbelievable figure of $85,000,000 has been invested in new plants in the past three years. And the activity is not stopping at this point; on the contrary it appears to be on the increase. Almost daily, plans for a new plant to be located in the states south of the Ohio and Potomac Rivers are announced.

Many other papers were delivered during the course of the conference. They covered cotton and its byproducts, sugar cane and its byproducts, rice, sweet potatoes, wood pulp, naval stores, tung oil, and soybeans.

T.V.A. Estimates Favorable Costs for Concentrated Superphosphate—I

By HARRY A. CURTIS, ARTHUR M. MILLER and J. N. JUNKINS
Tennessee Valley Authority, Knoxville, Tenn., and Wilson Dam, Ala.

Basing its calculations on the results of a period of experience with the production of electric furnace phosphoric acid and concentrated superphosphate ranging intermittently from late 1934 to the present, the Tennessee Valley Authority has prepared estimates of the cost of producing such concentrated superphosphate in a proposed plant which would apply the Authority's discoveries to the fullest advantage. Production of electric furnace phosphoric acid in the plant at Wilson Dam, Ala., was described in an article appearing on page 320 of the June, 1935, issue of *Chem. & Met.* Use of the acid in making concentrated superphosphate was taken up in September, 1935, page 488. A later evaluation of operating results was presented in August, 1936, page 408. The present article, which will be concluded in our December number, shows that the concentrated product can be delivered for less than standard superphosphate except at receiving points that are very close to the producing plant.—Editors.

IT HAS BEEN recognized for a long time that substantial savings could be made in handling costs, bags, freight and various other items if a more concentrated superphosphate than now in common use were manufactured and shipped. Distribution costs on nearly all commodities have become a heavy burden on the consumer, and this is particularly true in the case of fertilizers.

It is not at all necessary that the cost per unit of "available" P_2O_5 at the factory be as low for the concentrated as for the common grade of superphosphate; the savings mentioned above will permit a much higher factory cost for the concentrated superphosphate and still give a low delivered cost at a point where freight is a considerable item. Consider, for example, the hypothetical case of an acidulating plant operating at Baltimore, manufacturing a superphosphate of 19 per cent available and 20 per cent total P_2O_5 at a cost in the storage pile of 38 cents per unit of available P_2O_5, i.e., $7.22 per ton of superphosphate. The cost per ton of superphosphate delivered at a point in New York State to which the freight rate is $4.50 would be about as follows:

Cost in storage pile	$7.22
Recovery, disintegrating, screening, bagging	1.00
Bags (burlap, less expensive than cotton)	1.00
State tax	0.20
Freight	4.50
	$13.92

This is approximately $73.26 per ton of available P_2O_5 or 73.26 cents per unit.

Let us now work back from this delivered cost to determine the cost of concentrated superphosphate in the storage pile which would have to be reached in order to compete. Assume that the concentrated superphosphate would carry 50.4 per cent available and 51.5 per cent total P_2O_5. It would require 1.984 tons of this product to furnish a ton of available P_2O_5. The cost items per ton of available P_2O_5, exclusive of factory cost in the stock pile, would then be:

Recovery, disintegrating, screening, bagging	$1.984
Bags	1.984
State tax	0.397
Freight	8.928
	$13.293

The permissible factory cost for available P_2O_5 in the concentrated superphosphate to allow delivery at $73.26 per ton of available P_2O_5 would be $73.26 — $13.29 = $59.97. That is, in order to compete with ordinary superphosphate (19 per cent at 38 cents per unit of available P_2O_5, a corresponding cost of 59.97 cents per unit of available P_2O_5 or $30.22 per ton of product is permissible for the concentrated product. As will be shown in the final summary of costs, a net cost of $23.74 per ton of concentrated superphosphate is a reasonable expectation, using the new process as developed in the T.V.A. plant.

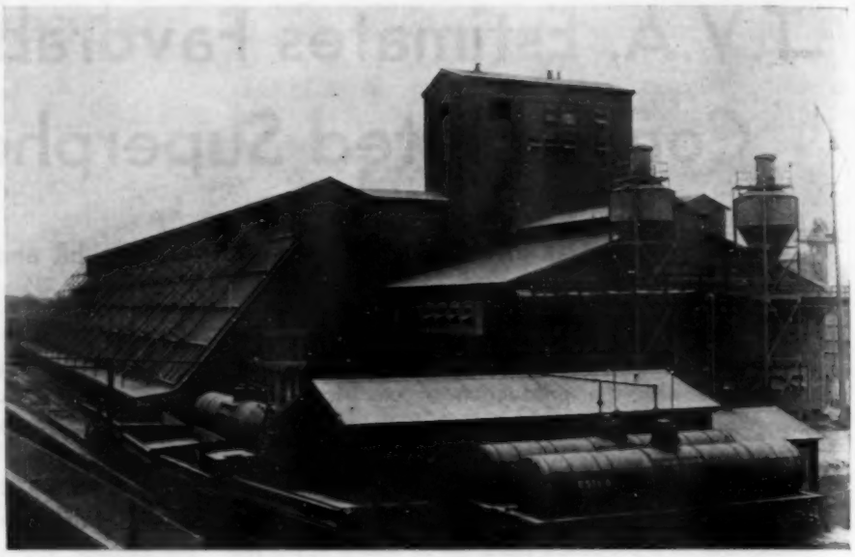
For ordinary superphosphate of lower grade (16 per cent) the case is still more favorable for the concentrated product.

The T.V.A. Fertilizer Works described in the earlier articles in *Chem. & Met.* is essentially an experimental plant in that the testing of equipment and processes and methods of operation have always been given precedence over production at maximum capacity. The superphosphate manufactured incidental to plant operation has been used in the T.V.A. fertilizer demonstration and watershed protection program.

It has been possible to study the operating characteristics and economy of individual pieces of equipment, but the plant as a whole cannot be considered as an economical commercial unit. It is only about half as large as it should be for a minimum commercial unit. Various parts of the old Muscle Shoals nitrate plant have been utilized, with saving of investment but with some disadvantages from the standpoint of economical operation. The actual out-of-pocket cost of the superphosphate produced is, of course, known accurately. It appears to be a hopeless task, however, to translate this cost into

one of commercial significance. The actual cost would have to be increased by so many items to allow for utilization of existing facilities, use of non-commercial freight rates, etc., and decreased by so many items to allow for interference with production by experiments, for increased labor and power costs in operating the existing facilities, etc., that in the end such an estimate would not rest on a very satisfactory foundation.

In the present paper an attempt is made to arrive at an evaluation of the electric furnace method of producing a concentrated superphosphate by laying out a plant of a reasonable commercial size, and estimating the cost of construction, cost of operation, and all other costs in such a plant. The experience gained in the T.V.A. Fertilizer Works as to equipment and construction costs, operating crew necessary, maintenance costs, operating results, etc., is utilized wherever applicable.



Extension of trisodium phosphate storage building at T.V.A. Fertilizer Works

Raw Materials and Product

The plant assumed for the purpose of the present cost estimate includes four electric furnaces drawing an average of 5,330 kw. each for 98 per cent of the total elapsed time during operating periods. (This value is taken because No. 2 Furnace at the Fertilizer Works was actually operated for a three-month continuous test period at this rate, as described in the August, 1936, issue of *Chem. & Met.*) A general description of the plant is given below. The raw materials required and the output are based on results obtained during the three months test run, except as otherwise indicated.

Quality of Phosphate Used—Brown phosphate rock from the deposits of Middle Tennessee will be used in lump form in the furnace charge and as dust in the final step of manufacturing superphosphate. The following is a typical partial analysis of such rock:

	Per Cent		Per Cent
Moisture	1.5	Al_2O_3	2.0
CaO	44.5	F	3.5
P_2O_5	32.5	CO_2	1.9
SiO_2	7.2	Miscellaneous	3.7
Fe_2O_3	3.2		100.0

Lump Rock Required—It was shown in the test run that 6,816 tons of phosphate rock was charged to one furnace in 90 days. The rock for four furnaces is then $6{,}816/90 \times 4 = 302.933$ tons per day.

Silica Pebble—In the test run it was shown that the furnace required 2,016 tons of pebble in 90 days of operation. Four furnaces would therefore require 89.6 tons of silica pebble per day.

Coke—In the test run 1,259 tons of coke was used in the furnace in 90 days. Four furnaces would therefore use 55.91 tons per day.

Coal—In the rather inefficient dryers at the T.V.A. Fertilizer Works it requires 27.6 lb. of coal to dry a ton of coke and 20.8 lb. of coal to dry a ton of silica pebble. The dryer provided in the plant herein described would be more economical of coal, but, in the absence of more specific data, the results obtained in the existing dryers are used. The coal required to dry the coke and silica pebble for the four furnaces is taken as 1.7 tons per day.

Yield of Acid—About 86.8 per cent of the P_2O_5 in the rock charged to the furnaces will be recovered in the acid produced. For four furnaces the P_2O_5 recovered in acid will therefore be 85.5 tons per day. The acid produced will be of about 80 per cent concentration. The weight of the acid will therefore be approximately 147.5 tons per day for four furnaces. At 68 deg. F. this acid will weigh approximately 102 lb. per cubic foot, and its volume will be 2,893 cu.ft. per day for the four furnaces.

Phosphate Dust Required and Superphosphate Produced—Using finely ground phosphate dust with acid of 75 per cent concentration, and using 90 per cent of the acid theoretically required (based on the CaO and P_2O_5 content of the dust), it has been found that, after 28 days storage, 95 per cent of the P_2O_5 in the rock dust has been converted to the available form. The superphosphate analyzed as follows:

	Per Cent		Per Cent
Moisture	1.7	Citrate insoluble P_2O_5	0.7
Total P_2O_5	51.1	Available P_2O_5	50.4
Water soluble P_2O_5	46.6	CaO	21.5
Free acid P_2O_5	0.4	F	1.6

The acid requirement in manufacturing superphosphate may be derived as follows: In 1,000 lb. of dust there is 445 lb. of CaO, requiring 1,128.4 lb. of P_2O_5. The dust itself contains 325 lb. of P_2O_5, so that the balance in the acid must be $1{,}128.4 - 325 = 803.4$ lb. of P_2O_5. The phosphate dust to be used with the 85.5 tons of P_2O_5 in the acid daily produced would then be $(325/803.4) \times (85.5/0.325) = 106.4$ tons per day.

If 95 per cent of the P_2O_5 in the phosphate dust becomes available, the total available P_2O_5 per 1,000 lb. of dust used with the requisite amount of acid would obviously be 1,112.15 lb. The superphosphate carries

50.4 per cent available P_2O_5, and its weight is then 2,207 lb. for each 1,000 lb. of phosphate dust used. The total dust used per day with four furnaces operating is 106.4 tons, and the superphosphate produced would therefore be $106.4 \times 2{,}207/1{,}000$ or 234.8 tons per day. (Actually the weight of superphosphate would be a little more than this inasmuch as several per cent more dust may be used than theoretically required to react with the acid.)

Proposed Plant

A general layout of the plant is shown in the accompanying drawing. The buildings housing the equipment are steel frame structures covered with corrugated roofing and siding of asbestos protected metal or some equally acid resistant material. Concrete floors are used in all buildings. The unloading trestle shown in the drawing is supported on wood and concrete bents with earth fill approaches.

Cost items covering all structures and equipment of the plant are presented in Table I and summarized in Table II. These items are discussed in the following:

Raw Materials—It is assumed that phosphate rock or sinter, dried and screened to proper size for furnace use, is delivered to the plant in hopper-bottom, gondola cars. Likewise coke and silica pebble of proper size for furnace use are delivered in such cars. Coke breeze is used.

Reserve Storage—Normally, the raw materials are transferred from the railroad cars directly to the proportioning building, passing through the dryer enroute only if the moisture content is too high to be tolerated in the furnaces. With a plant of the size postulated, and with shipments of raw material coming from distances of 30 to 100 miles, it would not be safe to omit a reserve storage. A raw materials storage building has therefore been provided.

A traveling crane carrying a grab bucket is used to move raw materials into and out of storage. The raw materials are dumped from the railroad cars into a pair of steel receiving bins which are mounted on railroad trucks. When a bin has been filled, it is drawn out from under the track hopper and into the storage shed where it is unloaded by the crane and grab bucket, the other bin being filled meanwhile. The crane and grab bucket may also unload raw materials directly from the railroad cars on the trestle, but as this is likely to damage the cars, and is slow if the crane must take each bucketful to the far end of the storage shed, it is resorted to only in an emergency.

From storage the crane and grab bucket move raw materials into a hopper feeding the dryer or into a hopper feeding a conveyor passing directly to the proportioning building.

Dryer—It is assumed that the phosphate rock or sinter is delivered to the plant in dry condition. The surface moisture which adheres to silica pebble may usually be disregarded, but the coke breeze requires drying and a dryer has been provided for this purpose, and, if need be, to dry the silica pebble. This dryer is of the rotary type, fired with coal.

Proportioning Building—The phosphate rock is screened to remove fines and the fines are picked up by an air-conveyor system and delivered to the fines storage silos shown on the plan. The screened rock is delivered into proportioning bins, of which there are three, each holding 200 tons. The coke and silica are delivered to bins of appropriate size. It is planned to deliver the raw materials to the proportioning bins only during the day shift in normal operation.

A weigh car of the mixing drum type is situated beneath the six proportioning bins. The coke, silica and phosphate rock are weighed into the car drum, mixed, and delivered to an elevator at the end of the proportioning building, whence the furnace charge is carried by belts to the furnace feed bins.

Electric Furnaces—Four rectangular electric furnaces are provided. These are fed continuously from overhead bins, the charge being led into the furnaces by pipe chutes extending through the furnace roofs at properly chosen points.

The three electrodes per furnace are each 30 in. in diameter and enter the furnace through seal glands. The electrode holders are of copper, well cooled by circulating water, and supplied with current from transformers situated immediately back of the furnace and as near to the furnace as possible.

The electrodes are received from the railroad cars in an electrode storage room at the end of the furnace building. They are handled by a chain hoist and monorail from the electrode room to the furnaces.

Slag from the furnaces is water-quenched and the granular product pumped to a silo over one of the railroad tracks, shown as an "Hydro Ash Tank" on the plan.

Acid Plants—The phosphorus bearing gas from each furnace is burned in a vertical burner, hydrated in the usual manner in a vertical acidproof brick tower, and passed through an electrical precipitator. The waste gas passes through an alloy steel fan after leaving the precipitator and then to a concrete chimney, 200 ft. high, lined with acidproof brick.

The precipitators are constructed of acidproof brick, with carbon electrode tubes. Acid from the precipitators and from the hydrators flows by gravity in open, acidproof troughs to a collecting tank common to the four acid plants. This collecting tank is of concrete, lined with lead and with acidproof brick. It is equipped with a stirrer to prevent sediment settling to the bottom. Inasmuch as the acid is used for production of

Plan of proposed plant for electric furnace phosphoric acid and concentrated superphosphate designed by Tennessee Valley Authority

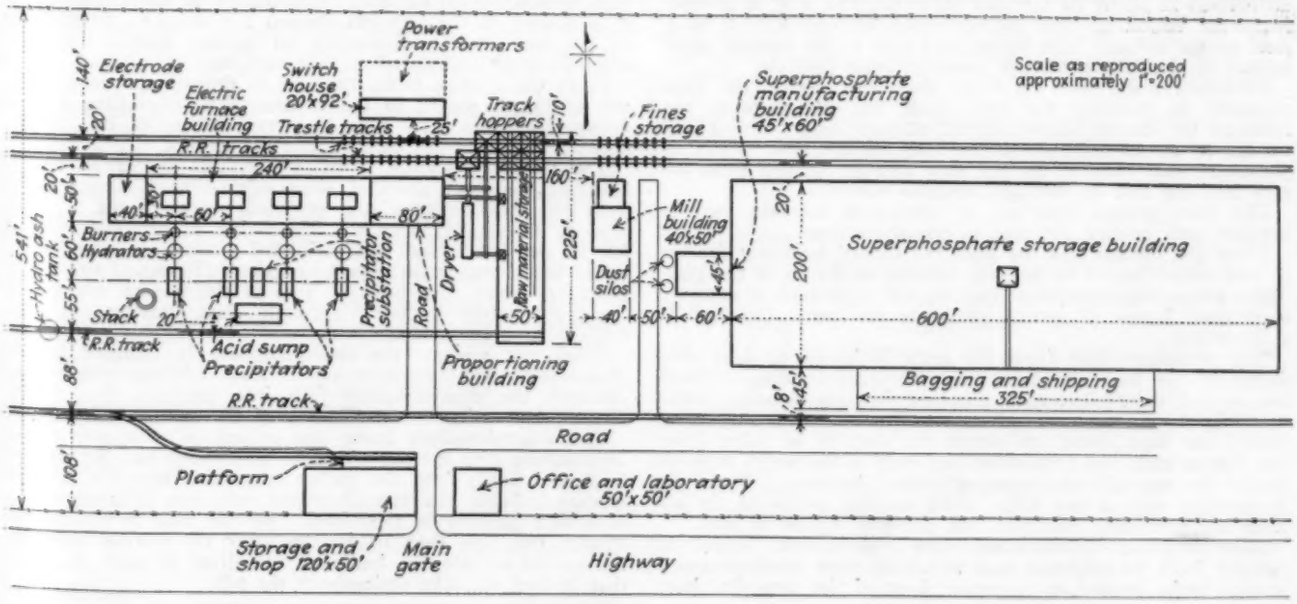


Table I—Detailed Costs of Plant Structures and Equipment

Raw Materials Storage

Structures	
Trestle 600 ft. long for handling raw materials, including hoppers and fill at ends of trestle	$35,000
Dry storage building 225x50x45 ft. steel frame, corrugated protected metal covering	38,000
	$73,000
Equipment	
Crawler crane and clamshell bucket	$25,000
Bridge crane and clamshell	15,000
Transfer car from trestle to storage building	8,000
Car pullers	5,000
	$53,000

Raw Materials Preparation

Structures	
Building 50 x 80 x 60 ft. steel frame, including six 100-ton storage bins, lighting, plumbing; bins to be suspended type steel, lined with tile	$43,000
Equipment	
Rotary weight car, motor driven	$5,000
Conveyors, 20-in. troughing belts, including motors and supporting structures	22,000
Bucket elevators, 14 x 7-in. buckets, including pits and foundations	7,000
Rotary drum dryer, including all accessory equipment, including foundations	20,000
Sample cutters	5,000
	$59,000

Pulverizing Mills

Structures	
Steel frame building 50 x 40 x 40 ft., including plumbing and lighting	$15,000
Fines and dust storage bins	20,000
	$35,000
Equipment	
Fine pulverizing mills	$31,000
Pneumatic conveying system	35,000
Screw conveyors and elevators	7,500
Miscellaneous chutes and ducts	5,000
	$78,500

Electric Furnace Department

Structures	
Steel frame building, 290 x 50 x 50 ft., plumbing and lighting	$184,000
Equipment, including foundation	
Transformers, 6,500 kva., 12,000 v. primary; 3 per furnace	130,000
Electric furnaces, rectangular type, 5,500-kw. capacity including electrode holders, winches, etc.	150,000
Electric switchboard and control equipment	30,000
Stock bins, chutes, and spouts	25,000
Slag disposal; hydraulic conveyors and feeders, supports	45,000
	$380,000

Acid Plant

Structures	
Acid sump, including canopy, concrete sump; three @ 15 x 15 x 10 ft. deep, lead and acidproof brick lines, steel frame canopy over sump	$25,000
Equipment	
Combustion chamber, hydrator	$85,000
Precipitators, including substation	230,000
Fan and blowers	18,000
Duct and flues	100,000
Acid pump	3,000
Water pumps	5,000
Piping, including yard lines and supports	20,000
Stack, 200 ft., concrete	16,000
	$477,000

Superphosphate Manufacture

Structures	
Steel frame building, 50 x 50 x 40 ft., including lighting and plumbing	$40,000
Equipment	
Three kneading type mixers	$32,000
Dust and acid scales	5,000
Screw conveyors and feeders	2,000
Dust silos	8,000
Piping	8,000
Acid storage tanks, lead-lined wood, including agitators and heating coils	8,000
Fume ducts and washing equipment, including fans	16,000
Conveyors and elevators	8,000
	$87,000

Superphosphate Storage

Structure	
Double A frame 600 x 200 x 60 ft.	$250,000
Equipment	
Monorail cars	$8,500

Office, Stores and Laboratory

Structures	
Office and laboratory building, brick and wood, 50 x 50 x 25 ft.	$25,000
Stores and shop building, steel frame, corrugated roofing and siding, 120 x 60 x 20 ft., including lighting, plumbing, and heating	30,000
	$55,000
Equipment	
Office and laboratory	$10,000
Shop equipment and shelving	20,000
	$30,000

Plant Services

Structures, electric	
Brick substation building	$17,000
Equipment, electric	
Switchboards and wiring	$68,000
Outdoor substation, electric	
Structure	$18,000
Transformers	140,000
Gear, switch	70,000
	$228,000
Structures, water supply	
Steel frame pump house, 30 x 30 x 15 ft., including foundation	$8,000
Equipment, water supply	
Pumps, fire and service	$10,000
Elevated tank and piping	20,000
	$30,000

Yard and Grounds

Grading	$5,000
Railroad tracks, including scale	60,000
Roads and walks	8,500
Fences and gates	6,500
Water lines	20,000
Sewer lines	18,000
Fire protection	6,000
Clean-up	3,000
	$127,000

superphosphate, there is no occasion to remove the suspended silica and other impurities.

The strength of acid from the precipitators and hydrators is maintained at about 80 per cent H_3PO_4. The acid is pumped from the collecting tank by chrome-nickel-molybdenum alloy steel pumps through high-silicon iron pipe to the storage tanks located in the superphosphate manufacturing building.

Phosphate Fines and Dust—As mentioned above, the fines produced in handling the lump rock for the furnaces are removed by screens located in the proportioning building and carried by an air-conveyor to the fines storage bins. Fines or phosphate sand received by rail may also be handled from the cars into the bins by the air conveyor system.

The fines storage bins are of reinforced concrete, two in number, each holding 200 tons of phosphate fines.

From the storage bins the fines are carried by screw feeders to two mills situated in the mill building as shown in the plan. These are air-swept mills, of the ring-roll type, each of capacity to produce 5 tons of ground phosphate per hour. One mill is a spare unit.

The phosphate dust from the mills is blown to dust silos alongside the superphosphate manufacturing building. There are two of these silos, each of about 70 tons capacity, cylindrical in shape, and mounted on steel towers. The supporting towers are high enough to permit the dust to be taken from the foot of each silo by a screw conveyor to the weigh hoppers inside the superphosphate manufacturing building. Each silo is provided with a bag filter which permits escape of the air from the pneumatic conveyor, but prevents escape of dust.

Superphosphate Manufacture—The phosphoric acid is pumped from the collecting tank to one of three relatively small storage tanks located on an upper floor of the superphosphate manufacturing building. These tanks are of wood, lead-lined, provided with stirring devices. Each holds 30 tons of acid.

The acid received from the collecting tank in the acid plant will be of about 80 per cent concentration. In the storage tanks it is diluted to the strength desired for use, i.e., from 72 to 78 per cent H_3PO_4, depending on various factors connected with the analysis of phosphate dust used, etc.

From the storage tanks the acid is drawn into weigh-tanks and is thence passed to the mixers. The phosphate dust is drawn from the dust silos by screw conveyors into weigh-hoppers and is thence dumped into the mixers.

The mixing operation is batch-wise, and is carried out in kneading machines provided with sigma-shaped mixing arms. Two of these mixers are provided, each having a bowl capacity (total) of 30 cu.ft. The charge of phosphate dust is 700 lb. per batch, with the calculated quantity of acid. Each mixer has a production capacity of about 15 tons of superphosphate per hour (dry basis). Two of the mixers will handle the plant output in one eight-hour shift, leaving the third machine as a spare unit.

From the mixers, the superphosphate is dumped onto a slow-moving pan conveyor 41 ft. long. At the end of the conveyor the superphosphate falls into the boot of a bucket elevator and is carried to the top of the storage building.

The superphosphate leaves the mixers as a crumbly mud. In tumbling onto the pan conveyor, and thence into the elevator boot, and finally into the trolley car which moves it into the storage building, the superphosphate rolls into balls of various sizes and hardens in this form. By the time it reaches the storage pile, less than 10 minutes after the mixing operation, the superphosphate has hardened and dried to such an extent that it does not cake seriously in the pile.

Superphosphate Storage Building—This is built in the form of a double A-frame building, with an aisle between the two parts. It is a steel-frame building 600 ft. by 200 ft., with protected metal roofing and ends. The roofing is placed under the roof trusses to protect the latter against acid fumes.

Along the apex of each A-frame is a monorail car carrying the superphosphate into storage. The car is electrically driven and automatically operated. The storage building has a storage capacity of about 48,000 tons of superphosphate.

The storage building is provided with a concrete floor, and in the middle of the floor is located a hopper to which the superphosphate is moved in recovering it from storage. The superphosphate is dug out of the storage pile by an excavating shovel and carried to the floor hopper by two dumpbody, gasoline-driven tractors. A conveyor running in a tunnel under the storage building floor moves the superphosphate from the floor hopper to the boot of an elevator which, in turn, carries the superphosphate to an upper floor of the disintegrating, screening and bagging building.

Inasmuch as the present study is concerned only with cost of superphosphate in the storage pile, the cost of equipment for moving the material out of storage is not included in the estimate.

Superphosphate Preparation Building—This building is adjacent to the storage building. It is equipped with standard machinery for disintegrating, screening and bagging superphosphate at a rate of 50 tons per hour. Provision is also made for delivering screened superphosphates in bulk directly to box cars on the railroad alongside the building.

Since cost of superphosphate in the storage pile is under consideration, the cost of this superphosphate building and equipment is not included in the estimate.

Shops and Stores—The shop and stores building is 60 ft. by 120 ft., one story high, having a covered unloading platform at car-door height adjacent to a railroad track. The building is divided into a machine and blacksmith shop, electrical shop, carpenter and lead burning shop, tool room, and storeroom.

Office and Laboratory—An office and laboratory building 50 ft. square and two stories in height, of masonry construction, is provided. This building is subdivided into offices and laboratories. A heating plant is provided for this building and the shops.

Outdoor Substation—The outdoor substation includes switching for two 110-kv. incoming circuits and a bank of three single-phase, 12,500-kva., self-cooled transformers, giving a total bank capacity of 37,500 kva. This transformer bank steps the voltage down from 110,000 to 12,000 volts. The outdoor substation also contains a bank of three single-phase transformers each rated at 833 kva., or 2,500 to a bank, for stepping down from 12,000 volts to 440 volts.

Indoor Substation—The indoor substation is housed in a brick building one story high, and contains control for the two outdoor 110-kv. oil circuit breakers and switch gear, wiring and control for six 12-kv. circuits and ten 440-volt circuits. The six 12-kv. circuits consist of one for the main transformer bank, four for the electric furnaces, and one for the 12,000/440 volt bank of transformers. The main power bank stepping down from 110,000 to 12,000 volts is connected solidly to the 12,000-volt bus, with provision for installing, if desired, an oil circuit breaker with its disconnecting switches. The ten 440-volt circuits are for nine feeders to the different buildings, of which one feeder is for emergency light and power purposes, and one circuit to the 12,000/440 volt transformer bank.

Electrical Distribution—The electrical distribution system is all underground and includes paper lead cable in fiber conduit from the indoor substation to the various buildings. Eight 12-kv. cables, two per furnace, run to the electric furnace building and nine 440-volt cables to the various parts of the plant for supplying power to motors and auxiliaries.

Table II—Summary of Plant Cost Items

	Structures	Equipment	Total
Raw materials storage	$73,000	$53,000	$126,000
Raw materials preparation	43,000	59,000	102,000
Pulverizing plant	35,000	78,500	113,500
Electric furnace plant	184,000	380,000	564,000
Acid plant	25,000	477,000	502,000
Superphosphate manufacture	40,000	87,000	127,000
Superphosphate storage	250,000	8,500	258,500
Office, shops, laboratory	55,000	30,000	85,000
Plant services	25,000	326,000	351,000
Yards, grounds	.....	127,000	127,000
Sub totals	$730,000	$1,626,000	$2,356,000
Contingent items	73,000	162,600	235,600
Totals	$803,000	$1,788,600	$2,591,600
Real estate	.....	.....	11,000
Grand total			$2,602,600

Table III—Summary of Depreciation Rates and Costs

	Depreciation rate, per cent	Original cost	Depreciation cost
Miscellaneous acid plant and lines	20	$33,000	$6,600
Mixers	20	35,200	7,040
Acid plants except stack and pipe lines	12.5	479,600	59,950
Tanks and silos	10	8,800	880
Monorail cars	10	9,400	940
Slag disposal	10	49,500	4,950
Electric furnaces	10	165,000	16,500
Pulverizers	10	28,600	2,860
Dryers	6.7	22,000	1,474
Cranes and cars	6.7	58,200	3,900
Conveyors and elevators	6.7	90,200	6,043
Water pumps and tanks	5	38,500	1,925
Concrete stack	5	17,600	880
Motors and electrical equipment	5	550,000	27,500
Sewers, water lines and railroads	4	203,000	8,120
Buildings	4	803,000	32,120
		$2,591,600*	$181,682

*It will be noted that this total assumes that all the contingent allowance will be used.

Motor control and wiring and lighting are similar to those installed in the present fertilizer works, and are included in the estimates for the equipment and buildings.

Water Supply—The process water supply is assumed to be obtained at the edge of the site by means of an intake well with a fixed screen and gravity intake pipe to a pumping station, 30 ft. by 30 ft., one story high. Process water pumps, a fire pump, and circulating water pumps for use in conjunction with the cooling tower, are located in this building.

An elevated water tower holding 100,000 gal. is provided, with a distribution system to supply process water where needed.

Railroad Tracks and Scale—Railroad tracks are provided for receiving and shipping purposes inside of the property lines. A railroad track scale is provided for use in measuring the weight of carloads of finished product. Car pullers will be provided for use with cars within the plant.

It is assumed that railroad weights are acceptable for the weight of incoming raw rock, and no weighing devices have been provided for this purpose.

Roads and Walks—Gravel roads are constructed to serve the various parts of the property. No walkways have been included with the exception of short walks at the office.

Fencing, Gates and Gate House—A Cyclone fence with gates is provided around the property. A small gate house is included.

Yard Lighting—Yard lighting is supplied by means of flood lights located on the various buildings.

Domestic Water Supply—Water lines, for drinking and domestic purposes, are provided within the limits of the property, making connection to some existing municipal service.

Fire Protection—Fire protection lines are provided to serve the various buildings, connected with the elevated water tank and fire pump, with necessary hydrants and hose houses.

Sanitary Sewers and Plumbing—Sanitary sewers are provided, extending from the various buildings to the edge of the property to an assumed connection. Plumbing items in the various buildings are included in the estimates for the buildings.

Storm and Process Sewers—Storm and process sewers are provided from the various buildings and yard locations, leading to the edge of the property.

Clean-Up of Debris. An allowance has been included in the estimate for cleaning up debris after construction.

Amortization

Approximately one-third of the plant cost is in buildings of steel, concrete and brick with protected metal roofing and siding. These are buildings of high initial cost and long life. A depreciation rate of 4 per cent has been used on buildings. They will probably be in good condition for twice the assumed life.

Where severe corrosion is encountered, as in furnace linings, precipitator wires, etc., the replacement becomes an item of repairs and maintenance as is indicated in the concluding section of this paper.

A detailed estimate of amortization along the lines indicated, which is presented as Table III, arrives at an annual cost of $181,682.

(To Be Concluded)

Electrochemical Industry Examines Its Power Problems

EDITORIAL STAFF INTERPRETATION

POWER for electrochemical industry was the central theme of chemical engineering interest at the 70th general meeting of The Electrochemical Society. These sessions, attended by 300 members and guests, afforded a basis for appraisal of past achievement and a substantial forecast of prevailing trends. In addition, the gatherings at Niagara Falls, Ontario, October 8-10, furnished the usual quota of scientific and electro-technical contributions, many of which deserve careful study by chemical engineers.

The two important symposiums pictured electric furnace contributions to civilization, and interpreted the pressing present problem of additional power supply. It was particularly appropriate that the first of these discussions should take place at Niagara, which has, during the past 40 years, been the major scene of the developments described. The second symposium, regarding future power supply, was no less timely because of current conditions making for shortage of energy resources to care for the pressing developments of electrochemical process industry.

Three outstanding electric furnace products were discussed in three papers which clearly pictured the past service of this industry to mankind. Carbide, graphite, and aluminum were the topics. But the story is much broader, and each important achievement or service might be paraphrased in other contemporary activity. Other papers on methods of achieving higher furnace temperatures, electric kiln ceramic manufacture, and numerous other themes, show clearly that this service trend will not soon be interrupted. Nor is it limited to activities commonly encompassed by the word, electrochemical. This is evident from a brief German contribution by W. J. P. Rohn on melting and casting metals in vacuo. The mechanical properties of steels so prepared are greatly enhanced. One of the most significant advances has been improved resistance of metal or alloy to fatigue and better service behavior, as evidenced by notched bar impact resistance.

The story of carbide in perspective, as presented by Witherspoon and Cadenhead, pictured an industry that might well on several occasions have declined instead of growing. It is a narrative of change, first acetylene for lighting, then for welding and cutting and for fertilizers, next the problem of war demand for chemicals previously made only from natural sources, and now a picture of synthetic organic industry and plastics. The emphasis on acetylene for welding and cutting, for cyanamide fertilizers, for the making of cyanides and other simple direct derivatives, has not been lessened. But far more spectacular are, of course, the synthetic chemical and "resin age" achievements. In the latter group of activities, the spot light was well thrown on three synthetic rubbers which, in the fundamental analysis, are based on the electrochemistry of successful, economic carbide making.

All of this and other contemporary industry achievement would have been impossible without the stimulus to a successful effort of equipment and electrode makers. These authors well picture the panorama of this phase of interdependent industry:

"The carbide industry early and naturally gravitated to Niagara Falls, where electric power was available in then 'unlimited' quantities, and it was here that the first commercial carbide furnaces were built. . . . At this point, demands began to be made on the electrical equipment industry. Large transformers and still larger transformers were in constant demand; and large electrodes. A 750 kw. transformer was the largest in existence when the carbide company demanded of the Wagner Electric Co. at St. Louis a 1,500 kw. transformer. It was a staggering request, and when the transformer arrived it was too big to go into the building through any window or door. . . .

"Carbon electrodes of 4 to 8-in. diameter were considered large. Nine-in. electrodes broke readily and often. Ten-in. ones were beyond consideration. It is a stimulating thought to look at the 54-in. electrodes in use today, and to realize that they do not break. It is also a fact, rather to be expected, that the production of carbide per kilowatt-hour is now almost three times that of the early days. At the present time 16 to 20 lb. of commercial calcium carbide is produced [per kilowatt-day]."

The graphitizing furnace, as described by E. C. Sprague, has been important to electrochemistry both because of the furnace techniques and because the products made were generally essential raw materials for further development of electrochemical industry. The story was a 40-year review, dating from the time when Acheson obtained his first patent on the manufacture of graphite, a patent that is basic to the work still practiced in the most advanced forms of the art.

During the reactions of graphitizing it is not possible to take samples of the furnace content and determine what progress is being made toward the desired product. Only by actual experience is it possible to schedule production of the desired form of bulk graphite or graphitized carbon article. And yet within this limitation, it is now possible to control the properties of graphite sufficiently to satisfy such exacting users as the dry cell makers, as well as the furnace users of big electrodes. With respect to electrodes, advance has been substantial as witness:

"Twenty-five years ago a 6-ton Heroult furnace would operate at 900 kw. and 110 volts, carrying about 5,300 amp. per electrode. If it finally poured its 6 tons of steel in 6 hours it was doing its job in a satisfactory manner. Today furnaces of somewhat similar size are operating at a load of 6,500 kw. or higher, at secondary voltages of 250 volts and down, and the electrodes are required to carry 25,000 amp., or even higher.

Moreover, these furnaces are expected to pour 10 tons of metal, starting from cold scrap, in about an hour and a quarter."

Outstanding recent advances of the aluminum industry, as presented by F. C. Frary, are found most spectacular in structural use and mechanical engineering. Here resistance to salt spray conditions, for example, has been an important chemical factor, but perhaps of less interest to chemical engineers than the specially surfaced or treated types. Notable among these is oxide-coated aluminum:

"For many years the anodic oxidation of aluminum in phosphate or borate electrolytes was used to a limited extent in condensers and similar articles. Subsequently the use of a chromic acid electrolyte was found to produce a thicker and stronger coating which was especially well adapted to serve as a basis for paint in the protection of aircraft structures. Finally, anodic oxidation in sulphuric or oxalic solutions has enabled us to put on still heavier coatings, and a variety of treatments makes it possible to control the adsorptive powers of these coatings so as to be able to cause or prevent adsorption of dyes, pigments, corrosion inhibitive chemicals, etc., at will. The superior hardness and abrasion resistance of these modern oxide coatings have given them a well deserved popularity among the users of aluminum articles.

"The most recent advance in this line of anodic treatment is the electrolytic brightening process (known under the trade name of 'Alzak'), which is unique in that a drawn and buffed aluminum surface having a reflectivity of about 70 per cent for light, after an electrolytic (anodic) brightening treatment and oxidation, lasting as long as 30 minutes, still retains its specular character and has increased in reflectivity to about 85 per cent. The oxide coating protects it against weathering and scratching from moderately careless handling. . . ."

It is notable also that for successful application new types of designs and new types of fabrication have been developed. The aluminum maker, like the advocate of alloy steels, has found it necessary to devise wholly new systems of structural or mechanical engineering usage. No less important have been the new methods of control of fusion and electrical welding.

Power Supply

Shortage of power for electric process industry impends. This was not stated, hardly even implied, by the formal papers of the convention. But lobby conferences, as usual the most important part of any convention, made it clear that electrochemical industry was actually already worried about needed expansion because corresponding supplies of energy did not seem available in suitable geographic areas.

This general observation put in good perspective the group of papers of the symposium on "Power for Electric Furnaces." And especially in the paper of J. W. Rickey, entitled "Hydro Power for the Production of Aluminum," was it evident that power supply for a great electrochemical enterprise is not casually arranged nor quickly achieved. That paper made clear that long vision and willingness to accept great financial risks were perhaps even more important considerations than a long purse. The story of Alcoa's power developments—one is tempted to call it an epic—gives easy "hindsight" to the reader and listener to appreciate why the rest of the symposium furnished but a small fragment of the needed engineering information on which to base the developments which lie immediately ahead of electrochemical industry.

Today U. S. power generating capacity is approximately 51 million kw., divided 36 in utility and 15 in industrial plants. Of this capacity 11 is hydro and 40 fuel burning. Under federal auspices an additional 2 million of hydro is being installed. These figures gave L. W. W. Morrow the springboard from which to present both his questions, and some startling conclusions. Outstanding among the latter were:

"The cost of power is about the same in all sections of this country, whether produced from water or from fuel. The cheaply developed hydro resources have been used, except for special situations such as those that exist at Niagara Falls, where other political and social factors enter into the situation.

"Power is cheapest and best if generated at or near the place where it is used. Any study of costs and performance shows that power can be transmitted only a relatively short distance and electrical power transmission over long distances is uneconomic and hazardous to service.

"Fuel-burning power stations can now be built for about $85 per kilowatt of capacity to produce a kilowatt-hour for about 12,000 B.t.u. This gives a cost of power at the bus bar of these stations at 50 to 60 per cent load factors of from 3.5 to 4 mills per kilowatt-hour. . . . One will be able to buy in the future a fuel-burning power plant at about $60 per kilowatt, to operate at around 10,000 B.t.u. per kilowatt-hour. Using the steam cycle only, this means that the cost of fuel-burning power will be had for about 3 mills per kilowatt-hour at the bus bar. . . . The trend in power cost reduction is in the direction of less expensive and better operating fuel-burning plants—not toward diesels or hydro plants.

"The mechanical life of a fuel burning plant is about 25 years. The fixed charges on such a plant to cover interest, taxes, insurance and depreciation are from 50 to 70 per cent of the entire cost of power. . . . Fuel economy at present prices of fuel cannot justify any large increase in investment. Whether a plant operates at 14,000 B.t.u. or 11,000 B.t.u. per kilowatt-hour is based upon the capitalized value of this fuel saving, and this dollar value is small in most instances. **It seldom pays to** modernize a fuel-burning station unless more capacity is needed.

"A cost of $250 per kilowatt of firm hydro capacity is representative of the hydro projects undertaken by the Federal government. At 50 per cent load factor and 10 per cent fixed charges, the cost of this hydro power at the station bus bars is about 6 mills. . . . With normal costs and charges, a transmission line and terminal stations at, say, 132 kv. will involve costs of about 2 mills per 100 miles of line per kilowatt-hour; at 220 kv. and 200 miles the cost will be about 2.5 mills per kilowatt-hour for usual loadings. For a good steam plant and normal coal and freight charges on a comparable basis the cost of coal delivered 100 miles would be about ¾ mill per kilowatt-hour, and for 200 miles slightly less than 1 mill per kilowatt-hour. In general, the cost of transmitting electricity by lines is about 2.5 times the cost of transporting fuels over distances of from 50 to 200 miles by rail.

"For ten years the trend in power supply has been to generate in comparatively small units at the loads and to use transmission only as a tie between these generating stations to take advantage of load diversity and to afford a margin of reserve capacity."

Hydro-Power Philosophy

Approaching the power problem from quite a different angle, R. J. Gaudy, under the euphonious title "Electrothermic Hydro-Nomics," stressed more the social than the engineering problems. His philosophy is well presented in certain of his own conclusions:

"The electrochemist must add social-mindedness and a thorough knowledge of the economic mechanism to his technical skill, since they are inseparable.

"Our civilization, if sustained, is to be built with the products of the industries to which electrochemists render personal service.

"Electric furnaces are good customers of the power companies because of both the direct and induced benefits created.

"Hydroelectric power is the most highly perfected and most reliable source.

"More operating contact is needed constantly between power vendor and large user, not a monthly glad hand call, but an hourly check between two operating control rooms.

"There is plenty of power available, even with hydro being exactly reciprocal of money costs. Transmission is costly for this industry.

"The Federal power program is a most attractive opportunity for further expansion of the electrochemical industry."

CO as a Chemical Raw Material

By NORMAN W. KRASE

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RAW MATERIALS used by the chemical industry may be classified as "primary" when referring to such natural resources as: coal, hydrocarbons, water, air, salt and certain mineral ores. While it is possible to foresee the exhaustion of supply of some of these and the consequent disappearance of processes depending on them, such a development is remote. From "primary" raw materials can be obtained certain products by combination or interaction that partake of the virtues of primary substances. Such derived products we may call "secondary" raw materials and confidently build an enduring chemical industry upon them.

Among the secondary raw materials are byproducts of coal processing, petroleum fractions, natural gas hydrocarbons, CO, CO_2, H_2, N_2, O_2, Cl_2, metals, etc. It seems safe to conclude that processes based on these possess the first requisite for continued success, *viz*, availability. This paper will review the situation regarding CO, one of the secondary raw materials, specifically as to its sources, present uses, and potentialities.

Carbon monoxide can be made from many carbonaceous materials but for industrial purposes one is limited to such sources as coal, coke, or naturally occurring hydrocarbons like petroleum or natural gas. The market value of liquid fractions of petroleum is such that only the low molecular weight hydrocarbons of natural gas or those formed in cracking processes, can be considered as starting materials. Type reactions by which CO may be formed from these substances are:

$$C + O_2 = CO_2$$
$$C + CO_2 = 2CO$$
$$C + H_2O = CO + H_2$$
$$2CH_4 + O_2 = 2CO + 4H_2$$
$$CH_4 + CO_2 = 2CO + 2H_2$$
$$CH_4 + H_2O = CO + 3H_2$$

CH_4 is representative of many low molecular weight hydrocarbons, either natural or byproduct. C is representative of coal, coke, charcoal and other forms of carbon in the free state.

It will be noted that the oxidizing agent used may be oxygen, air, carbon dioxide or water. In addition to these there is the possibility of employing oxides of metals:

$$3C + Fe_2O_3 = 3CO + 2Fe$$
$$3C + CaO = CO + CaC_2$$

Such processes give rise, in some instances, to fairly pure gases containing high concentrations of CO.

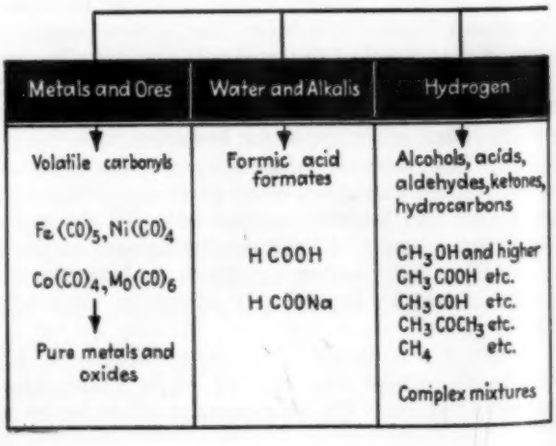
Table I.—G sification of Coal and Coke

Constituent	Per Cent by Volume			
	Coke-Oven Gas	Producer Gas	Blast-Furnace Gas	Blue Water-Gas
CO	5.0- 6.0	22.0	26.2	41.4
CO_2	1.5- 2.5	5.7	13.0	4.2
H_2	48.0-57.0	10.5	3.2	49.2
CH_4	28.0-33.0	2.6	....	0.8
O_2	0.5-0.6	....	....	.1
N_2	3.5- 4.5	58.8	57.6	4.3
C_2H_4	2.5- 5.5	0.4	....	....
(Gross) B.t.u./cu. ft.	530-600	136	93	307

Consider now the principal industrial sources of carbon monoxide: The four gases described in Table I are available in tremendous quantities in many industrial areas. Considered as sources of CO they differ in many respects. The value of unpurified gas is determined almost entirely by the cost of competing fuels or power in the locality. Correcting for CO content and neglecting other factors, we can compare the cost of CO before separation or other treatment as given in Table II.

Table II.—Comparative CO Values of Gases

Gas	B.t.u. Basis	Relative Cost Corrected for CO Content
Blast furnace	1.0	1.0
Producer	1.5	1.2
Blue Water	3.3	5.3
Coke Oven	6.1	13.0



Presented under the title: "Carbon Monoxide as Raw Material for Chemical Synthesis" at the Baltimore meeting of the American Institute of Chemical Engineers, Nov. 11, 1936.

Many factors enter to modify the order shown in Table II, depending on the use to which CO is to be put. If pure CO is required, such costs as gas cleaning, purification and separation must be considered. For example, complete removal of suspended solids from blast-furnace gas would be expensive; the application of compression and liquefaction methods (for CO separation) to this gas and to producer gas would make the presence of large percentages of N_2 a costly disadvantage. If a purified mixture of CO and H_2 is to be produced, blue water-gas possesses obvious advantages. Other valuable constituents obtainable as byproducts (C_2H_4 from coke-oven gas) of the separation process would furnish a credit to be deducted from the cost of CO production. The fuel value of gas remaining after treatment must not be overlooked on the credit side of the process selected. Present practice indicates that blue water-gas is the cheapest source of CO and CO-H_2 mixtures for industrial synthesis in regions close to coal deposits.

Conversion of Hydrocarbons.—Natural gas is being widely distributed over the United States and is available at fuel prices in large volumes. Refinery gases resulting from the cracking of petroleum fractions are to be classed with natural gas from the standpoints of price and availability for CO production. Typical compositions of these gases are given in Table III; although considerable variation is found among samples from different sources.

Table III.—Gas Compositions

Constituent	Natural Gas	Refinery Gas
CO	0	....
CH_4	70.1	84.8
C_2H_6	26.8	....
C_nH_m	0.9	8.3
H_2	0.0	5.2
CO	0.0	0.4
CO_2	1.3	.8
O_2	0.1	.5
N_2	.8	....

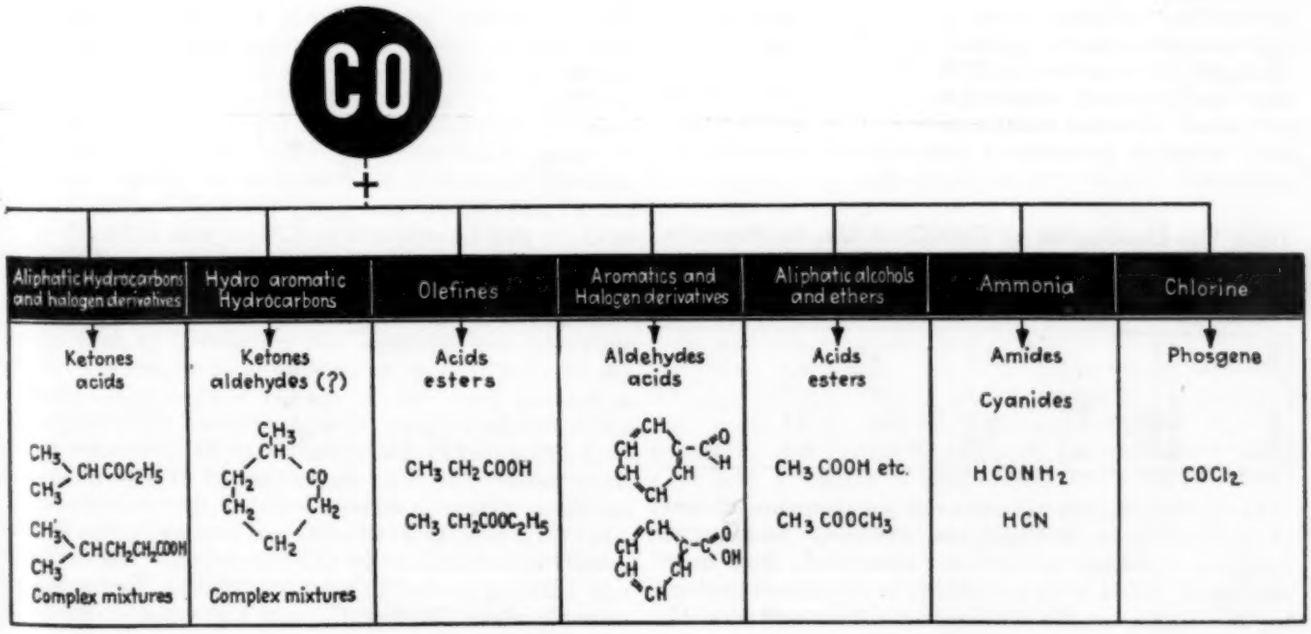
By subjecting hydrocarbon gases to reaction with O_2, air, steam or mixtures of these, products containing CO are formed. The composition of such products depends on the ratio of oxidizing agent to hydrocarbon, on temperature, pressure, time of contact and catalytic agents used. A commercial process now operating at the Standard Oil Co. of Louisiana, Baton Rouge, uses natural gas and steam; the Standard Oil Co. of New Jersey, Bayway, uses refinery gas and steam. Initial reaction takes place under the influence of catalysts at 1600 deg. to 1800 deg. F. and between 1 and 15 lb. per sq. in. Numerous other examples of existing processes could be given. Present processes are operated for the production of H_2 rather than CO and subsequently treat the products formed in the initial reaction with additional steam and catalyze the mixture at about 850 deg. F. The additional H_2 formed is equal to the CO converted to CO_2.

Using CH_4 as a typical hydrocarbon, and considering the principal reactions that it undergoes with water, the equilibrium compositions of the gas mixtures at 1 atm. total pressure are shown in Table IV. Data are taken from Schmidt ("Das Kohlenoxyd," Leipzig, 1905). Since hydrocarbons can react in both ways shown, the actual composition of gas obtained will depend largely on the catalyst used. The favorable effect of high temperatures on eliminating hydrocarbons from the gaseous products is apparent.

Table IV.—Equilibrium Compositions of Gas Mixtures at Total Pressure of One Atmosphere

Temp. Deg. F.	$CH_4 + H_2O = CO + H_2$				$CH_4 + 2H_2O = CO_2 + 4H_2$			
	CH_4	H_2O	CO	H_2	CH_4	H_2O	CO_2	H_2
788	....	....	....	....	23.6	47.1	5.9	23.4
932	33.3	33.3	8.33	25.0	....	....	....	....
995	....	....	....	....	15.8	31.6	10.5	42.1
1175	12.5	12.5	18.75	56.3	9.5	19.0	14.5	47.2
1310	5.56	5.56	21.2	66.7	....	....	....	....
1409	....	....	....	....	4.4	8.8	17.3	69.5
1535	2.65	2.65	23.7	71.0	....	....	....	....
1634	....	....	....	....	2.1	4.1	18.7	75.5
1796	0.51	0.51	24.8	74.1	....	....	....	....
2120	....	....	....	....	0.4	0.8	19.7	79.1

Coke-oven gas, which may contain 20 to 35 per cent CH_4 as well as additional hydrocarbons, may be converted with steam and air (or CO_2) to yield richer



CO-H_2 gases. One of the papers presented before the recent Chemical Engineering Congress in London (3) gives the small scale results shown in Table V using steam and O_2 on a partly purified coke-oven gas.

Table V.—Conversion of Coke-Oven Gas With Steam and Oxygen

Constituent	Coke Oven Gas	Converted Gas
CO	4.8	14.0
CO_2	0.0	6.0
H_2	57.8	60.0
CH_4	21.0	0.7
C_nH_m	1.8	0.0
O_2	1.1	0.0
N_2	13.5	19.3

Byproduct gases of certain established industries are frequently excellent sources of CO. For example, in producing calcium carbide by the electric furnace method a gas of approximately 60 to 65 per cent CO is evolved. Gaseous products of wood distillation analyze about 25 per cent CO and over 50 per cent CO_2—a somewhat variable although concentrated source. Electric furnace production of elemental phosphorus yields concentrated although limited quantities of gas from which CO could easily be recovered.

Separation From Gas Mixtures

Liquefaction.—Commercial processes for separating the constituents of gas mixtures by liquefaction methods are well known. The Linde cycle, utilizing the Joule-Thomson effect, and the Claude cycle in which gas is cooled by expansion in an engine to recover some of the power used for compression, have found wide application. For CO production by these methods, it has been necessary to solve certain technical problems that can be treated only briefly in this paper. Depending on the source of gas, there will be present varying amounts of gaseous constituents that liquefy and solidify more readily than does CO. Such solidification results in continuous accumulation at low temperature regions in the equipment and ultimately causes stoppage of flow: Steam, CO_2, C_6H_6, and similar vapors behave in this manner and the liquefaction process must provide for their complete removal at moderately low temperatures, obtainable, for example, by NH_3 refrigeration. CO_2 and water are commonly removed by means of solid NaOH treatment. Chemical reaction between constituents sometimes results in formation of solid products of dangerous properties.

Table VI.—Liquefaction of Coke-Oven Gas for Ammonia Synthesis

Constituent	Original Per Cent	After CO_2 Removal	C_nH_m Fraction	CH_4 Fraction	CO Fraction	Residual Fraction
CO_2	3.2	....	....	....	....	....
C_nH_m	2.6	1.8	36.7	1.9	....	....
O_2	1.0	1.0	....	1.2	2.0	....
CO	6.3	6.6	2.0	9.6	18.0	....
H_2	46.9	49.3	....	4.2	....	75.0
CH_4	26.2	26.6	30.8	74.4	6.9	....
C_2H_2	1.0	1.0	30.6	....	....	....
N_2	13.1	13.7	....	8.7	73.1	25.0

In the liquefaction of coke-oven gas containing traces of nitrogen oxides and acetylene, care must be taken to avoid the formation of explosive compounds from these substances. There is the possibility, in this case of modifying the coking conditions to reduce the amount of C_2H_2 and nitrogen oxides formed. Whatever the source of gas, there is always necessity of devising suitable purification methods, and these are not infrequently significant items in the final cost of CO. Borchardt (1) gives results of coke-oven gas liquefaction by the Linde process, (Table VI) producing NH_3 synthesis gas. The C_2H_{2n} and CH_4 fractions would make excellent gases for further treatment with steam (and O_2) to produce CO. At present it appears best to recover olefines as such for particular chemical syntheses.

A brief description of the liquefaction process as applied to coke-oven gas is given by Scholvein (2). He states that the CO fraction contains 26.7 per cent CO. When water gas is liquefied for CO production, the process is obviously much simpler than when coke-oven gas is used because of the smaller number of constituents present.

Chemical Separation.—Carbon monoxide may be separated from gas mixtures and recovered in concentrated form by treatment with aqueous solutions of copper salts. The sequence of steps is somewhat similar to that used in producing CO_2 for dry-ice manufacture using Na_2CO_3 solution as the scrubbing agent. Absorption takes place at about room temperature in packed towers and at elevated pressure (frequently 200 atm.). Regeneration of the solution and recovery of CO is accomplished by heating the solution to 40-50 deg. C. in a partial vacuum, purifying and drying the evolved CO.

Cuprous salts, in either acid or ammoniacal solution, are used. Oxygen should be excluded from the gas treated since cupric salts, formed by oxidation are of no value in the process. When ammoniacal solutions are used, chlorides and sulphates should be avoided; copper carbonate and formate, are satisfactory (4). For acid absorption, copper chloride seems best (5).

Properties of Carbon Monoxide

From the thermodynamic standpoint, CO is stable at room temperatures with respect to the elements from which it is formed. There is considerable tendency for CO to decompose into CO_2 and C; at 25 deg. C. and atmospheric pressure, only 2×10^{-2} per cent CO remaining at equilibrium. In the absence of catalysts the decomposition proceeds very slowly. In the presence of O_2 there is a strong tendency to form CO_2; in the absence of catalysts this reaction begins at about 1200 deg. F., using either air or O_2. The flammability limits at ordinary pressure and temperature of CO-air mixtures are 6.3 and 71.2 per cent CO. The physiological activity of CO is well known; 0.15 to 0.20 per cent CO in air give definite symptoms after one hour exposure and 0.5 per cent causes death in five to six minutes.

Since CO is frequently employed at elevated pressures, stored in steel cylinders, and transferred in steel tubes, the effect of iron on its stability is of importance. Even in massive form, iron is reactive toward CO. Bartlett and co-workers report (6) one per cent CO_2 in originally pure CO stored in steel cylinders at 100 atmospheres for three weeks. The exact mechanism of CO_2 formation is not clear. There is definite evidence that iron carbonyl, $Fe(CO)_5$, is formed from CO and iron and its formation usually is accompanied by CO_2 formation. The carbonyl may catalyze further CO decomposition. The carbonyl, unstable above 216 deg. C., may also cause difficulty in

industrial handling of the gas by decomposing at elevated temperature and depositing iron and carbon in lines or on catalysts. Where feasible, steel surfaces should be protected by copper, which seems to be inert toward CO at low or moderate temperatures.

The behavior of CO on compression is similar to that of nitrogen. In the lower pressure range (to 600 atm.) CO is slightly more compressible and in the higher range (to 1,000 atm.) slightly less compressible than nitrogen (6).

Reactions of Carbon Monoxide

Metals and Metal Oxides.—It is not the purpose of this paper to discuss metallurgical processes in detail but rather to cover the applications of CO to more strictly chemical operations. It seems desirable, however, to mention recent developments now being actively prosecuted that are closely related to and will affect the chemical industry.

Current practice involves the reduction of ores by coke and its oxidation products to produce metals. In certain ways, the use of gaseous reducing agents such as H_2, CO, and hydrocarbons would result in smaller and simpler equipment, yield a purer metal, and permit more precise control of operating conditions. Certain ores of iron, zinc, nickel, and tin are adaptable to this treatment and commercial progress is being made. Hydrogen is somewhat expensive for such processes although water gas from coke and steam is used. Frequently a portion of the gas leaving the reduction zone, and containing considerable CO_2, is recycled after reduction with coke. The sequence of reactions for iron oxide would be:

$$Fe_2O_3 + 3CO = 2Fe + 3CO_2$$
$$CO_2 + C = 2CO$$

The non-reducible constituents of ore remain and further treatment is necessary to separate the metal. Magnetic properties of the metal, differences in fusion temperatures of metal and gangue, and differences in specific gravity have all been the bases of proposed separation methods. With the gradual solution of technical difficulties we may expect increasing commercial application of gas-reduction methods of ore treatment.

Several metals possess the property of forming volatile compounds with CO. These compounds are called carbonyls. Iron, nickel, cobalt, molybdenum, and tungsten are the industrially important metals that have been investigated. While the information is largely in the patent literature (7) sufficient scientific data on properties and reactions exist to predict increasing utilization of these substances in industry. Carbonyls are used for the preparation of very pure metals and oxides as well as for limited miscellaneous purpose. The carbonyls are usually produced by reaction between clean metals and compressed CO. The upper limit of temperature is about 200 deg. F. and the most frequent pressure employed is 200 atm.

Alkalis.—That CO will combine with alkalis has been known since 1856 when Berthelot (8) investigated the production of sodium formate at ordinary pressure by the combination of CO and sodium hydroxide. Other alkalis, including NH_3, react in a similar way in varying degrees. The reaction with NaOH is favored by increase in CO pressure and by low temperature. Actual operating conditions range between 50 and 200 deg. C. and above 40 atm. pressure (9). Simple packed towers, in which concentrated caustic solution flows downward, countercurrent to the CO, are used.

Formates may be produced by reaction of CO with sodium chromate (10) at 250 deg. C. and 50 atm., with alkali carbonates or bicarbonates at 300 deg. C. and 50 atm. (11) and with alcoholates (12). Further discussion of the behavior of alcohol and derivatives is included later in this paper.

The direct synthesis of formic acid by the reaction between CO and water may be found in the patent literature (13). Steam and CO are catalyzed by various substances under pressures reaching 1000 atm. As far as is known, no production of formic acid by such a process has been reached commercially. There is a real difficulty to be overcome in this direct synthesis, namely, the unfavorable equilibrium at even moderate temperatures. The product resulting from the reaction contains only a small percentage of acid (14).

Hydrogen.—The utilization of CO-H_2 mixtures in the chemical industry is important not only because valuable synthetic products are obtained but also because the starting materials for such syntheses are readily and cheaply produced from the primary raw materials, coke and steam. The last fifteen years have witnessed an astonishing growth in many countries of industries using purified water gas for the production of hydrocarbons, alcohols, acids, liquid fuels and miscellaneous oxygenated organic compounds.

It is possible to write chemical equations using CO and H_2, and products formed from these, to show how numerous aliphatic hydrocarbons, alcohols, acids, esters, ketones, and aldehydes may be formed. Fischer (15) proposed a mechanism which at that time involved certain reactions not experimentally tested. Since then, however, each step in his proposed sequence has received experimental verification. The large number of possible reactions in this system is, doubtless, an attractive factor but it gives rise also to the outstanding difficulty, namely, the separation of the complex mixture of substances found in the reaction products. To have reasonable market value for chemical purposes, products must be fairly pure or composed of only a few constituents at most. Two methods of solution present themselves (a) develop highly selective catalysts and carefully controlled operating conditions to produce pure compounds or (b) develop separation methods applicable to complex mixtures. Progress has been marked in both directions, with the second method probably more widely used.

Methanol.—In 1921 Patart (16) was granted a patent covering the production of methanol by the direct combination of CO and hydrogen. His experimental work showed that mixtures of copper and zinc oxide were effective catalysts, that pressures of 150 to 200 atm. were necessary, and that temperatures between 300 deg. and 600 deg. C. gave best results. Following this work many patents (17) and scientific articles appeared. An excellent summary of equilibrium data (18) and a discussion of catalysts and side reactions (19) are available. The commercial success of the process not only abroad but particularly in the United States is a matter that needs no recapitulation (20). The development has resulted in raising production from 500,000 gal. in 1927 to 10,000,000 gal. in 1930 and low-

ering the price from 72 cents to 42 cents during the same period. While the wood distillation industry has undoubtedly suffered, the stimulating effect on industries using methanol and the growth of new uses is a striking example of chemical engineering progress.

Higher Alcohols.—While methanol synthesis is the best known and most important development based on CO-H_2 reactions, mention must also be made of the production of alcohols of higher molecular weight. Such production is well established commercially; it does not, however, approach methanol on a volume basis. The mechanism of synthesis seems fairly well known. Frolich and Cryder (21) propose that two molecules of methanol condense to form ethanol and water. Ethanol undergoes a similar condensation resulting in butanol. These hydrations may yield ethers as intermediate compounds.

$$2CH_3OH = C_2H_5OH + H_2O$$
or $$2CH_3OH = CH_3OCH_3 + H_2O$$
and $$CH_3OCH_3 = C_2H_5OH$$

The establishment of conditions and development of catalysts (22) to facilitate such a series of condensations starting with $CO + H_2$ have resulted in marked success. In general, metallic oxides, active in the synthesis of methanol, will yield higher alcohols if alkaline substances are added to them, although one finds in the patent literature many substances of special composition claimed as catalysts for higher alcohol synthesis (23).

The composition of the products obtained varies greatly and complete analysis is difficult. An extensive investigation of the fraction boiling above methanol has been made by Graves (24). The crude mixture was obtained after fractionating methanol from the products of alcohol synthesis at the Belle plant of the du Pont company. It boiled between 85 and 162 deg. C. Analysis showed 48.5 per cent by weight to be primary alcohols in which normal propanol, isobutanol, and 2-methyl-1-butanol predominated. A smaller fraction contained secondary alcohols in which were identified isopropanol and 3-methyl-2-butanol. Many other alcohols as well as aldehydes and ketones, are present in small amounts. Higher alcohols find use as solvents, for preparation of acids and esters, high compression aviation fuel, and miscellaneous purposes.

Liquid Organic Compounds.—In this group are included the complex, liquid mixtures made from water gas where the primary purpose is the production of liquids from gases without regard to separation difficulties. In Europe such mixtures have a market as motor fuel; in the United States plentiful supplies of petroleum prohibit general use as fuels. It is not unreasonable, however, to look forward to the time when lowered costs of production combined with increased prices for petroleum products will permit conversion of coal into gas and then into liquids for use in internal combustion engines. Fischer (15), (25) has outlined this development in Germany.

Of more immediate interest is the synthesis of oxygenated organic compounds corresponding to the fatty acids and alcohols now obtained from natural fats. Long chain hydrocarbons, C_8 to C_{12}, have been synthesized from CO and H_2; the commercial feasibility depends on low cost hydrogen, which is used to reduce CO, and is lost as water. Another approach to such synthesis is discussed in the next section.

Saturated Hydrocarbons and Derivatives.—The availability of large quantities of fairly pure aliphatic hydrocarbons from natural gas and from petroleum processing has prompted investigation looking toward their utilization for other than fuel purposes. Among the promising developments has been the product of CO reactions with these hydrocarbons. With saturated aliphatic compounds and CO it is possible to bring about combinations, usually under the influence of aluminum chloride and related substances, that yield oxygenated products of value. In a sense, this is an extension of the well known Friedel and Craft reaction, which for many years was thought to be limited to aromatic hydrocarbons. The use of CO under elevated pressure with $AlCl_3$ has opened up the possible utilization of many types of hydrocarbons. Looking on these reactions merely as a method of introducing oxygen into a hydrocarbon molecule, they should be compared with other known methods of accomplishing the same result, namely, the use of air and oxygen for partial oxidation, and the use of oxidizing agents generally.

Our knowledge of partial oxidation processes involving air and aliphatic hydrocarbons reveals extremely difficult temperature control problems in these exothermic reactions, and frequently large losses as CO_2 and H_2O. Also, the products are usually complex mixtures of substances difficult to separate. The use of other common oxidizing agents (such as $K_2Cr_2O_7$ and H_2O_2) is usually ruled out on cost considerations. While CO reactions of this type suffer from some of the same drawbacks (complexity of product and low yields), temperature control is simple because the reactions proceed below 100 deg. C. and in many instances at room temperature. Research is gradually improving yields and developing more selective reactions.

Most of the present published information is in the patent literature. Normal pentane with CO at 150 atm. and heated with $AlCl_3$ at 60 deg. C. yields a 6-carbon carboxylic acid and a 6-carbon ketone (26). Petroleum "ether" yields oxygen-containing compounds such as ketones (27). Both aliphatic and hydroaromatic hydrocarbons yield similar products with $AlCl_3$ and substances like $ZnCl_2$, $FeCl_3$, $SbCl_5$, $AlBr_3$ and $SnCl_4$ (28). Halogen derivatives such as C_2H_5Cl and C_4H_9Cl yield acids and ketones on treatment with CO and $AlCl_3$ and subsequent hydrolysis (29).

Not enough information is available to generalize on the type of ketone formed from a given hydrocarbon; it appears, however, that the carbonyl group is usually near one end. Oxidation of such ketones will form aliphatic acids, the length of the chain being dependent on the length of the hydrocarbon chain originally used. Such a synthesis of fatty acids is potentially important because these substances are finding increasing use as starting materials for producing detergents, emulsifying agents, etc., and are now obtained from relatively expensive natural fats.

More detailed information on experimental conditions for hydrocarbons from methane to hexane as well as halogen derivatives and cyclo-paraffins has been given by Hopff (30). An excellent review in English is available (31).

Olefines.—Reactions of olefines, CO, and water vapor resulting in the formation of aliphatic acids, constitute a distinct field of potentially great significance. A typical reaction is:

$$C_2H_4 + CO + H_2O = \underset{\text{propionic acid}}{CH_3CH_2COOH}$$
ethylene

One interpretation of mechanism would involve the successive reactions:

$$(A)\ C_2H_4 + H_2O = C_2H_5OH$$
$$(B)\ C_2H_5OH + CO = C_2H_5COOH$$

Reactions such as (B), between alcohols and CO, are discussed later. Patents furnish most of the published information (32) although some laboratory results are available (33). Further reactions between the acid and olefine constitute a new method of ester production that deserves intensive investigation (34).

$$\underset{\text{acetic acid}}{CH_3COOH} + C_2H_4 = \underset{\text{ethyl acetate}}{CH_3COOC_2H_5}$$

All of these are vapor-phase catalytic reactions under elevated pressure.

Aromatic Hydrocarbons and Derivatives.—As early as 1906 Gattermann revealed that aromatic aldehydes could be formed from aromatic hydrocarbons and CO under the influence of $AlCl_3$, Cu_2Cl_2, and HCl (35). At ordinary pressure, however, benzene failed to react. Recently, the use of elevated pressures has extended the method of synthesis not only to benzene (36) but also to such derivatives as toluene, xylene, mesitylene and diphenyl (37). Patents on processes for syntheses have appeared (38). The type reaction is to combine benzene and CO to form benzaldehyde. Conversions of 60 to 80 per cent on the basis of the hydrocarbons have been obtained, the conditions being ordinary temperature and pressures up to 30 atm.

The directness and simplicity of the process, the possibility of producing chlorine-free products, and the general applicability of the reaction make it of much interest. Standing in the way of immediate commercial utilization is the cost of relatively large quantities of $AlCl_3$ necessary in these reactions. Research looking toward the employment of more truly catalytic substances or permitting the recovery and re-use of $AlCl_3$ could easily change the commercial outlook.

An interesting synthesis of benzoic acid from monochlorbenzene, CO, and steam (39) probably involves the reactions:

$$C_6H_5Cl + CO = \underset{\text{benzoyl chloride}}{C_6H_5COCl}$$

$$C_6H_5COCl + H_2O = \underset{\text{benzoic acid}}{C_6H_5COOH} + HCl$$

A 96 per cent yield of benzoic acid is claimed.

Aliphatic Alcohols and Ethers.—One of the most significant developments involving CO is the formation of acids from alcohols according to the type reaction:

$$CH_3OH + CO = \underset{\text{acetic acid}}{CH_3COOH}$$

Evidence exists to support the statement that this is a general reaction for aliphatic primary alcohols and proceeds to some extent with secondary alcohols. It may be that these reactions are actually the result of dehydration of alcohol to give an olefine and water and then combination as discussed in a preceding section. Whatever the mechanism, it must account also for the production of formates:

$$CH_3OH + CO = \underset{\text{methyl formate}}{CHOOCH_3}$$

A limited technical literature is available. Hardy (40) has studied the reaction with methanol, ethanol, normal and isopropanol, and normal, secondary and isobutanol. Singh and Krase (41) have reported on semi-works experiments using methanol. A considerable patent literature on this synthesis exists (42), evidence of the keen industrial interest in the commercial aspects. From a fundamental point of view, a process based on coke and steam and following the sequence: water gas, methanol, acetic acid (ethyl alcohol, propionic acid; propyl alcohol, butyric acid, etc.), seems to possess distinct advantages over present processes based on food byproducts, wood, or those requiring considerable electrical energy. Processing costs might well delay commercial realization but all indications point to satisfactory progress in this direction. In fact, preliminary cost estimates do not exclude the conversion of acids to alcohols by reduction with hydrogen; in the case of ethyl alcohol this would be a complete reversal of present practice.

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Wood-flight escalator for taking bags and barrels from ground floor to storage bins.

Batching GLASS— ELECTRICALLY

IN THOSE chemical industries which lend themselves readily to continuous handling of materials, great strides have been made through the use of conveying systems — automatically controlled and mechanically, hydraulically or pneumatically operated. In those processes which by their nature are limited to batch procedure, progress has been more difficult but no less evident. An outstanding example in this latter field is afforded by the electrically-controlled materials handling system in the Macbeth-Evans Glass Co.'s new plant at Charleroi, Pa.

As a manufacturer of a highly diversified line of glass products requiring a number of different types and grades of glass, the Macbeth-Evans Co. was confronted with the task of modernizing its manufacturing procedure to keep pace with a rapidly increasing demand. It became apparent that the old method of mixing the raw materials for the glass batch was inadequate. All materials except sand were being brought in by bag and barrel and then hand shoveled into wooden bins. From the bins the materials were again shoveled as needed into containers and weighed on a platform scale. The resulting time losses and inaccuracies of the system loomed large as costly deterrents in the face of a growing market.

Final action on the matter resulted in the construction of an entire new batch plant designed according to the most modern layout principles. Benefits from the new plant have been fourfold. Larger quantities of bulk material can be handled with the attendant savings of quantity lot purchasing. Labor formerly engaged in materials handling has been made available for other plant work. The chances for contamination of materials have been almost entirely eliminated. Batch uniformity has been insured by electrical weighing and discharge control.

In the new plant, bulk material such as sand, soda-ash, limestone and feldspar, is received in box cars and unloaded by means of a power shovel into a bucket elevator which carries it to the top of the building where it is discharged onto a distributing belt. The elevator is composed of reinforced buckets on a heavy duty belt and is enclosed in a dust-tight steel casing. It is mounted on 78-ft. centers and has a two way discharge spout at the top, so that it may discharge either into a sand screen or onto the distributing conveyor. There is a revolving feeder at the bottom to regulate the flow of material to it from the power loader. At the present time, two men using the power shovel can unload an average of six cars per week. Soda-ash, limestone and sand cars require 2½ hours each, feldspar cars about 3½ hours. The old method of unloading took four men eight to nine hours per car of sand.

From the unloading elevator the materials go to a distributing belt conveyor which conveys to storage bins and is discharged by means of a self-propelled belt tripper which can be spotted over the openings in the tops of the different bins. There are 20 bins of 1500 cu.ft. capacity, arranged in five groups of four bins each, and eight intermediate ones of 27 cu.ft. capacity, arranged in two groups of four bins each. Directly below these 28 bins are seven electrically controlled batchers with multiple and single beams, each batcher serving a group of four bins.

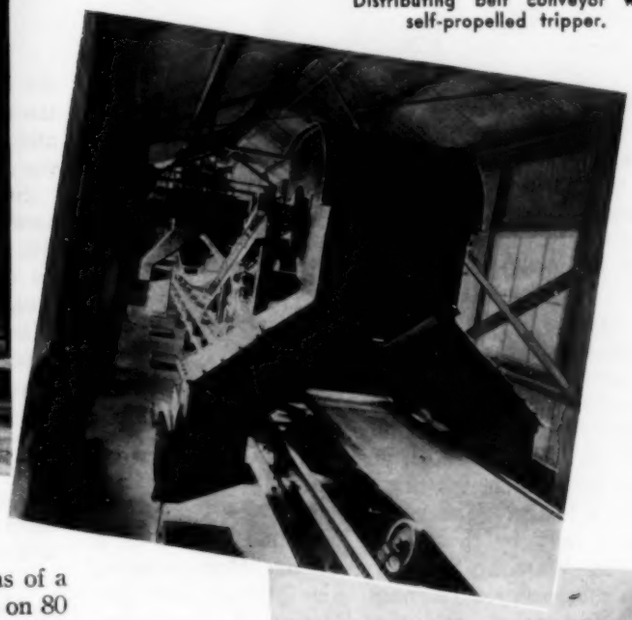
In addition to the large and intermediate bins there are 12 bench bins for material used only in small quantities. Material for these and the 27 cu.ft. bins is brought up

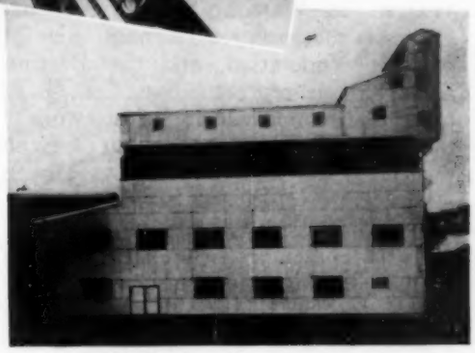
Power shovel unloading contents of boxcar into bucket elevator.

elevator shaft. After the unloading of each car, the downcoming elevator buckets are blown out with air and the resultant dust is drawn out at the foot of the shaft. Paper and other foreign material from the box car are either caught by prongs in the car door chute or by a wire mesh in the elevator boot hopper. In wet or windy weather provision is made for running a tarpaulin from the elevator up over the cars so that no water or dust can get into the car door chute.

The material in each car is checked as it is unloaded

Distributing belt conveyor with self-propelled tripper.





Macbeth-Evans Glass Co. plant at Charleroi, Pa.

from the ground floor in bags and barrels by means of a wood-flight escalator. The escalator is 40 in. wide on 80 ft. centers and is driven by a 5 hp. motor. It is reversible so that empty containers may be returned to the ground floor.

Three men do all the mixing from the 28 bulk and 12 bench bins in about 4½ hours per day whereas the old plant required seven additional men to do the same amount of work. These seven men are now employed in other departments of the plant. Two men run the mixer and screen material from the mixer into the batch carts while one laborer is used to work around the plant keeping the place clean and assisting the other men.

The batchers are electrically controlled to insure accuracy. After the required amounts of raw materials are drawn into the batcher hopper from the bins above, the gate of the hopper cannot be opened until electric signals show that all bulk bin gates are closed and electrically locked. The material from the batcher is then discharged onto the gathering belt conveyor which is provided with a magnetic head pulley for the separation of metallic foreign particles from the charge. From this belt, which is 30 in. wide on 75 ft. centers and enclosed in a dust-tight steel case, the batch is discharged into a batch gathering hopper. It then falls into the batch mixer through an air-operated gate controlled from the mixing room floor.

Prevention of contamination is a most important consideration in batch work, particularly where so many different materials are handled in the same apparatus. At the new plant, the elevator chutes and distributing belt conveyor are easily cleaned by means of a compressed air stream which is supplied through a line built into the and then sent to the bins, each of which is fully enclosed and equipped with a locked gate. The key can be secured from the batchhouse superintendent only after he has rechecked the contents of the bins.

From the storage bins through the batchers and onto the batch mixers via the collecting belt, the material moves through a closed dust-tight circuit. This serves to provide cleaner working conditions as well as guard against contamination.

Both the building and the mechanical handling systems are so designed that they can be extended when necessary.

Responsibility for the construction of the new plant was placed in the hands of J. H. Farrell, K. K. Knaell and Henry H. Blau of the Macbeth-Evans Co., assisted by G. F. Sherratt and G. E. Mahoney of the Chain Belt Co. The electrically controlled batchers were manufactured and installed by the Blaw-Knox Co.

HANDLING CARBOYS

THE HAZARDS attending the use of strong corrosive liquids are so great that only the most careful practices should be employed. During transportation, containers filled with these liquids are handled by many individuals who either are not familiar with their dangerous characteristics or are careless. Although producers can train their employees in proper safe practices, it is impossible for them to control the actions of all probable handlers. It is therefore a moral obligation of shippers to pack such products in the best and safest containers obtainable and to see to it that these containers are kept in first-class condition.

Glass carboys, when properly cushioned or suspended in wooden boxes, are extremely rugged containers and will withstand excessive abuses. Through many years of use, certain practices for handling, loading and emptying carboys have been proved safe and can be recommended without reservation. The Carboy Committee of the Manufacturing Chemists' Association has studied the many problems which have arisen and has worked out solutions based on scientific investigations by several shippers. Most of this data is published in the form of carboy manuals for both shippers and consignees and can be obtained from the Manufacturing Chemists' Association for a nominal charge. It would take years for any individual shipper to acquire this information.

Maurice F. Crass of E. I. du Pont de Nemours & Co., Chairman of this committee, through his untiring efforts is largely responsible for this contribution to the heavy chemicals industry. The value of the work is properly appreciated only by those who have had a part in it. Warren N. Watson, Secretary of the Manufacturing Chemists' Association, through his interest and sympathetic cooperation, and the Bureau of Explosives, through their representative, Col. G. E. Carleton, have been of inestimable help in this work. As evidence of the results obtained, the Bureau of Explosives report for the year 1935 shows 64 carboys broken in transit with a loss of only $1,512 as compared with 744 broken carboys and a loss of $22,635 in 1921.

In the September issue of *Chem. & Met.*, the types of available packings for carboys were described and those features which provide the best container were listed. The choosing of the right package, however, is only the starting point. The package must be tested, maintained in good condition, filled, closed, handled, stored and transported in such a manner that accidents will not result.

Safety depends on a careful and persistently wide-awake attitude in regard to all of the operations through which a carboy must pass. The possible danger cannot be emphasized too strongly, and to avoid trouble one must be constantly alert. For instance, the working area where carboys are filled and closed should be well lighted, properly ventilated, clean, and the housekeeping should always be of the best. Water should be readily available for use in case of accident. The workmen should be carefully trained in proper methods of filling, handling and closing the containers. They should be equipped with goggles, rubber boots, gloves and aprons. All equipment and tools used for this work should be of the best and maintained in an A-1 condition.

Carboys used for shipping certain corrosive, inflammable, and poisonous liquids must be made to conform to Interstate Commerce Commission 1A specifications which require an approved method of closure and provide for a breakage test to be made semi-annually. This test, conducted on the regular swing test apparatus, consists

Improper stacking during transportation results in high breakage losses.

SAFELY

By R. W. LAHEY
American Cyanamid Co.
New York, N. Y.

Above: A tilter offers the simplest and safest method of emptying.

Left: A long-handled truck for carrying filled carboys.

of swinging ten water-filled carboys at a distance of 55 inches, striking against the side, and swinging five carboys at the same distance but striking against the bottom. In order to be satisfactory for shipments, 90 per cent of the carboys must withstand this test without breaking. At one of the tests, an inspector of the Bureau of Explosives is present, and the other test is conducted by the shipper.

A series of tests must be made for both new and used carboys. A new carboy is defined as a new or old bottle packed in a new box with new packing. Tests are usually made in the spring and fall in order to avoid extreme cold weather. Reports must be submitted on Bureau of Explosives Form No. 6 and signed by the shipper. Any shipper who regularly fills and ships carboys with dangerous liquids is compelled by Interstate Commerce Commission regulations to make these tests. Exemption from the tests applies only in the case of a distributing station which fills carboys for a single shipment, and where the carboys are obtained from another plant where proper reconditioning and periodic tests are made.

The volatile character of most acids has presented a problem in the sealing and venting of carboys. Some years ago the porous clay stopper was devised. This has proved to be a great help, since its porosity provides in some degree for the passage of gases. Drawings of two of the several types in general use are reproduced on these pages. Asbestos rope containing not less than 98 per cent pure asbestos is required for gasket material. The best way to apply the gaskets is to make two complete winds of the rope around the flange of the porous stopper. This completely covers the flange and provides the maximum bearing surface on the bottle mouth. The outside end of the gasket is usually tucked under to prevent movement. Some shippers will remove most of the twist from the rope before applying it, while others prefer to retain the twist.

With the gasket in place, the stopper is put in the bottle and gently tapped home. It is fastened by a looped soft wire not lighter than 14 B.w.g. The loop is applied under the lip of the carboy neck, and the single wire extending from the loop is passed over the groove in the stopper and down on the other side to the loop, around which it is twisted. Some shippers pass it through the loop before twisting while others contend it is just as safe to twist without passing through the loop. The advantage claimed for the latter method is that it is easier to remove and less chipping of the necks occurs. The regulations require only one wire, but some shippers use two wires applied at right angles to each other for additional safety, as the wires are always subject to corrosion by gases venting through the porous stoppers. To minimize this, care should be taken to see that the black paint used in coating these wires is of a bituminous compound and has maximum flexibility. Wire of 13 B.w.g. is often used. A few shippers have recently adopted 18-8 chrome nickel wire ties for securing stoppers in nitric acid service. This acid is very likely to fume in hot weather and corrode ordinary wires.

Pure gum rubber gaskets are tighter than the asbestos material and will prevent seepage to a much greater extent. Of course these gaskets can be used only on carboys containing muriatic acid. They make such a tight seal that if by any chance the clay stopper is not porous the gases will not be able to vent.

The air space above the contents level in a carboy, better known as the "outage," should be determined on the basis of the expansion and contraction of the contents under abnormal changes in temperature. It should be assumed that there will be no pressure developed through volatility, as the porous stopper should take care of this. There should always be a minimum outage of 6 inches from the top of the bottle, and some liquids require more. No carboy should be shipped with the contents showing above the top of the box.

Carboys should be stored under cover, but if this is not possible they should be kept off the ground with dunnage of sufficient thickness to allow for free circulation of air. Filled carboys should never be piled more than three high and in the case of nitric acid, not over two

Above: Deceptive use of cap to hide breakage.

Right: Carrying sticks can be used for short distance transportation.

high. In hot weather the stoppers on carboys containing volatile liquids such as nitric and muriatic acid should be loosened. Nitric acid should not be exposed to bright sun light.

Employees should be carefully trained in the handling of filled carboys. Before moving, the closure should be inspected to make sure there has been no leakage and that the wires are securely placed and have not been corroded. The top should always be pointed away from the handlers and they should be removed far enough from the container so that if breakage does occur the employee will be safe. A good method is to use trucks with long handles that grip the box under carrying cleats. There are several trucks of this type on the market. Carboys may also be carried by two men holding the container between them on sticks which are placed under the carrying cleats. The disadvantages of this method are added cost and the possibility of carelessness or negligence which may result in the dropping of the carboy. Grasping of the bottle neck should be avoided at all times and the carboys should not be walked or turned on their bottoms any more than absolutely necessary.

The practice of using neck protections, hoods, caps, or hats has been encouraged by many railroads. This is to be condemned because the handler then cannot see the condition of the closure and more accidents are liable to result. The railroads are gradually recognizing this fact and are changing their tariffs to allow shipments of both filled and empty carboys with necks unprotected.

Loading and bracing of C.L. and L.C.L. shipments of filled and empty carboys are fully covered by instructions issued by the Bureau of Explosives. These instructions are printed in the Manufacturing Chemists Association carboy manuals and in Bureau of Explosives Pamphlet No. 6.

In opening a carboy the workman should keep hands and face to the side and never over the bottle mouth. The wires should be cut with wire cutters of the face type. Removal of wires by twisting often results in cracking or chipping the bottle neck and thereby endangers the worker.

The best method of emptying carboys is to use a tilter, of which there are many on the market. Under no consideration should air pressure be used. The emptier has an important moral obligation to all those engaged in transportation in that *he must be sure that all carboys which he empties are thoroughly drained*. Failure to do this not only violates the Interstate Commerce Commission regulations but endangers all handlers of the empty container. Many accidents have resulted from the spilling of acid from so-called "empty" carboys.

Carboys should not be refilled by the consignee nor should they be used for liquids other than that originally contained. Empty carboys returned to the filler should be washed to prevent contamination of the product. They should be thoroughly inspected before storing, and those requiring repairs should be segregated from those which are satisfactory for refilling. Periodically, the bottoms of carboy boxes should be carefully inspected since corrosion of the nails makes that part the most susceptible to failure. Inspection and repair is the controlling factor in the prevention of ordinary breakage. Those carboys which are constantly kept in a good state of repair are in a much better position to resist the shocks of transportation and handling. The recoopering or repairing of carboys depends largely on the type of packing in use and the construction of the box.

Boxes are ordinarily constructed of New England or Western pine of a minimum thickness of 25/32 in., although some users prefer ⅞-in. lumber, claiming that the longer life obtained more than offsets the additional cost of the material and the additional transportation cost due to the extra tare weight. Carrying cleats are nailed to opposite sides of the box and extend the full width of the sides. They are sometimes beveled on the under side to provide better gripping. The bottom cleats or shoes are applied to opposite sides of the bottom of the box and they must run parallel to the carrying cleats. The ends are beveled for ease of movement. In general all cleats are the same thickness as the box and the width is four times the thickness. The regulations allow certain deviations from this practice but this is the most popular specification.

There are two common types of construction used for the boxes. One is the Verity type, which is

usually made of straight lumber and each side laps one adjacent side and butts the other side. There are ordinarily three pieces on each side and all nails are in the corner posts. Usually there are three widths of side pieces. One of each width is used in each side of the box and the position of these pieces is staggered on adjacent sides so no two joints will come together. The corner posts are triangular and measure $1\frac{1}{2}$ in. on the two sides adjacent to the box.

The advantage claimed for this construction is that it facilitates replacement of worn boards at a minimum cost. The claimed disadvantages are that the box weaves when moved and, in the event of a broken bottle, there is possibility of injury to the handler through leakage at the side joints, unless they are tongued and grooved.

The other type of box construction is that in which two opposite sides are fitted into grooves in the other two sides. This construction can be made with straight lumber, tongued and grooved or Lindermann jointed. Repairs on this box are not made as easily as on the first type because of the greater difficulty of fitting new pieces into a jointed structure.

In putting the wooden bottom in the box, any type joint may be used. It is desirable to provide some holes in the bottom for ventilation. This will help to deter corrosion of nails and wood. The cleats are usually attached at the edge of the box but they are sometimes set in an inch or more from the edge. In this latter case the skids can be attached by the shook manufacturer and the box can be set up without nailing the bottom through two thicknesses of lumber.

The hole in the cover which allows the bottle neck to protrude causes a weakness in the box top. If there is a joint in the lumber at the circular hole, the cover often cracks and breaks off from the pressure of tiering. This condition can be improved by having a center piece of lumber wide enough to accommodate the hole.

The carboy repair shop should be equipped with benches on which to rest the box. A stock of repair parts should be provided, the nature of which will be determined by the size and construction of box used and by those replacements which are needed most frequently. A stock of tops, bottoms, carrying cleats and bottom cleats should be maintained at all times, as these parts require replacing more than any others.

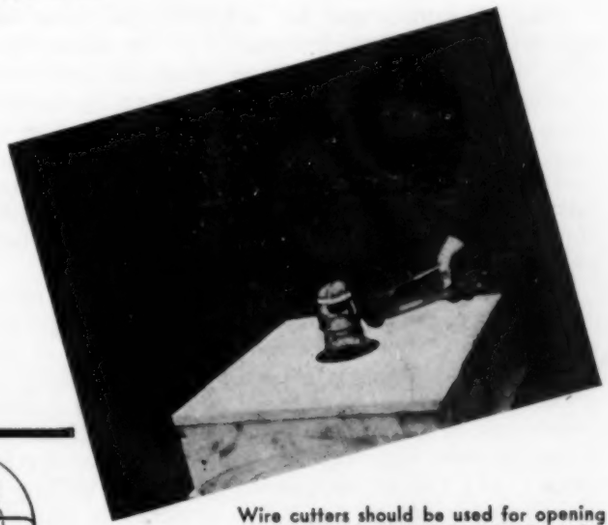
The bottle should be removed before repairs of any nature are made on the box. The cost of removing the bottle is relatively high and the box should therefore be gone over thoroughly and all partially worn parts replaced.

In an effort to make boxes last as long as possible some shippers are inclined to make excessive repairs. This is often uneconomical, particularly if it is probable that further repairs or scrapping of the box will become necessary in a relatively short time, such as six to nine months. The repair cost as compared with the cost of a new box and packing should be considered in every case. If the men are properly trained they will soon be able to decide quickly which is more economical. Often the question cannot be settled at the first inspection, since many necessary repairs cannot be seen until the bottle has been removed.

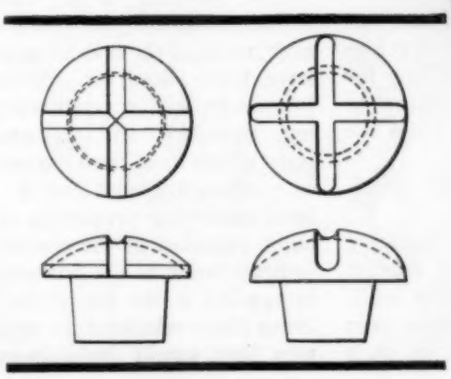
Nails are always a point of danger because of possible corrosion from acid. A good deal of work has been done on this problem but to date nothing more satisfactory than a cement-coated sinker nail has been found. The cement coating provides additional holding qualities and as the sinker type has a cone shoped head the additional metal will last longer than the ordinary flat headed common nail. Six and eight penny nails are commonly used. For attaching the covers, most shippers use common nails without coating because these parts are often removed and replaced.

To summarize, the shipper who devotes sufficient time to investigating and choosing the best types of packing and boxes, who insists upon maintaining these containers in first class condition, and who takes upon himself the responsibility of thoroughly training his employees in safe handling practices, will be compensated by lower costs per trip and a minimum of accidents.

Photographs reproduced with this article were supplied through the courtesy of the Manufacturing Chemists' Association, the Merrimac Chemical Co., and the Lewis-Shepard Co.



Wire cutters should be used for opening carboys. Removal of the wire by twisting may result in a broken bottle neck.



Two of the several general types of porous clay carboy stoppers.

Gas Industry Trends

By R. S. McBRIDE
Editorial Representative, Chem. & Met.
Washington, D. C.

GAS ENGINEERING is again getting more attention by the technical men of the public utility gas industry, both the manufactured and natural gas divisions. For several years past this industry has found it necessary to give far more attention to merchandising and public relations matters. It has, therefore, probably rightly, somewhat neglected the scientific and technologic problems which seemed less pressing, though probably in the long run not less important.

Even now, at the recent meeting of American Gas Association, it is evident that engineers are being called on for matters of management, sales, and public relations. The engineering method of approach is even being applied aggressively to matters of rate structure, for classification of customers, and appraisal of price schedules.

It is noticeable also that this industry is finding it essential to study the related and interlocking problems of gas and petroleum more intensively than ever before. This is true not only of natural gas, but also of manufactured gas units which hitherto have been regarded merely as customers of the petroleum refinery.

Natural Gas

Sales of natural gas for industrial fuel have been aggressively pressed the last year or two by utility executives. As a consequence, pipeline owners are quite happy in a number of cases where they see capacity demands being imposed on their long-distance transmission systems. The supposed surplus for Chicago, coming a thousand miles from the Panhandle of Texas, has been marketed so effectively that the special sales organization assigned to this problem two years ago is now being transferred to other projects.

Even in the East, some of the lines reaching metropolitan areas have been actively negotiating arrangements which will augment utility and industrial sales in their territory. The result is expected to place capacity demands on these eastern-seaboard pipelines. As a consequence, one needs no very long vision to anticipate that within the next year there must be one of two developments: (1) Further exploration and deeper drilling for gas in proven areas. Or, (2) a tendency to return to larger scale water-gas production, and possibly even the building of more coal-carbonizing capacity.

A novel situation affecting natural gas and utility business has been experienced in the Rochester, N. Y., district. There, a field operator, none too cooperative with other gas reserve owners, has chosen to market directly to big industrial customers, on a non-utility basis. As a consequence, a merry controversy continues over the legality, as well as the economic prospect, of such efforts. The railroads, anticipating a loss of fuel hauling business, have joined utility enterprises in an effort to stop this marketing, attacking specifically the plans for Eastman Kodak Co. to buy natural gas direct from the field to use as a boiler fuel.

Whether it will be found that the builders of the proposed pipeline can go ahead without a state certificate of public convenience and necessity, remains uncertain. But even if the project is carried forward, there remains serious doubt as to the economic future, particularly as to the length of time which the limited fields of northern Pennsylvania and southern New York can withstand such special drains. Most serious prospect is that the threat to withdraw this gas will stimulate other nearby gas operations and quickly exhaust the entire field. Nearby utility executives, of course, would like to see this area held as a reserve of enricher gas to be used in public-utility systems. The case can well be studied by any process industry executives who may be asked to buy gas in large blocks direct from field owners on an extra-utility basis.

The affiliation of utility enterprises with natural gas is also emphasized by the common interest in marketing of bottled liquefied petroleum gases. This effort to render "gas service beyond the gas mains" is regarded by municipal-system executives as a pioneering to be encouraged. The concept of home use of gas is driven home in suburban and rural areas and the worth while customers conserved. In fact, as one executive says, "We don't want them to become too much electricity conscious before we can get there with our mains." This same philosophy has, however, apparently not been applied by the utility man to prospective users of propane and butane on an industrial scale. The disinterested observer wonders why there is not as much community of interest here as with respect to the household.

Coke Quality

The blending of low-volatile and high-volatile coals for manufacturing of coke has been long practiced. However, most of the operating mixtures used by the industry have been based on empirical rather than fundamental knowledge of the relationships involved. All coke makers, therefore, will welcome the series of semi-works tests which have been carried out at the Bureau of Mines in cooperation with the A. G. A. committee which has been surveying properties of American coals. These results, reported at the convention by J. D. Davis, clearly indicate some of the limitations to blending which should be applied in the use of the particular coals investigated. Since these relationships appear rather general in implication they would probably guide the user of other coals

also. The results, as summarized by Mr. Davis, are most importantly:

1. In general the strength of the coke is improved by adding up to 20 per cent of the low-volatile to the high-volatile coals. There is one exception; that is, the resistance to shock of the coke from Upper Banner coal is not improved by adding 20 per cent of either a low- (Beckley) or a medium- (Sewell) volatile coal.
2. The tendency is for addition of 30 per cent of the low-volatile coal to produce a stronger coke than 20 per cent; but it is evident that 30 per cent of Pocahontas is too much for Alma coal and 30 per cent of the Beckley is too much for the best results with Upper Cedar Grove.
3. Additions of 20 per cent of the Sewell and Beckley coals to the Upper Banner produce cokes of about the same strength. When 30 per cent of these coals is added it appears that the Sewell gives the best results.
4. Blending 30 per cent of Beckley coal with 70 per cent of Warden produces as strong coke as that from 100 per cent Beckley. Warden alone produces a much weaker coke than Beckley.

The question of blending of coke breeze with raw coal, in order to minimize the amount of fines to be disposed of, is also an important gas-works problem. Additional data on the possibilities involved have been gathered by a special sub-committee under the chairmanship of F. J. Pfluke. After extended trials at several commercial works this committee concludes that such blending of fine coke with coal is permissible under many circumstances. Especially when using a strongly caking coal a large part of the breeze produced may be disposed of in this fashion. The resulting coke does not lose strength and may within limits actually be improved if the breeze used is uniformly fine and properly premixed. This procedure clearly indicates an advantageous plan, especially where the market for breeze is limited or the market price much lower than that obtainable for full-size coke.

Petroleum Relations

Gas makers are important customers of the petroleum industry. They make many common products and have many other technical features alike. As a consequence, D. W. Wilson in his analysis of the economics of oil refining has reached the conclusion that the gas man might well also become a small-scale refiner of petroleum or some of its heavy fuel-oil products. He proposes specifically that a heavy oil coking unit be used by the gas man for the processing of either crude or low-grade heavy fuel oil. The products would be coke, gas oil, heavy enricher gas, and a small quantity of motor fuel.

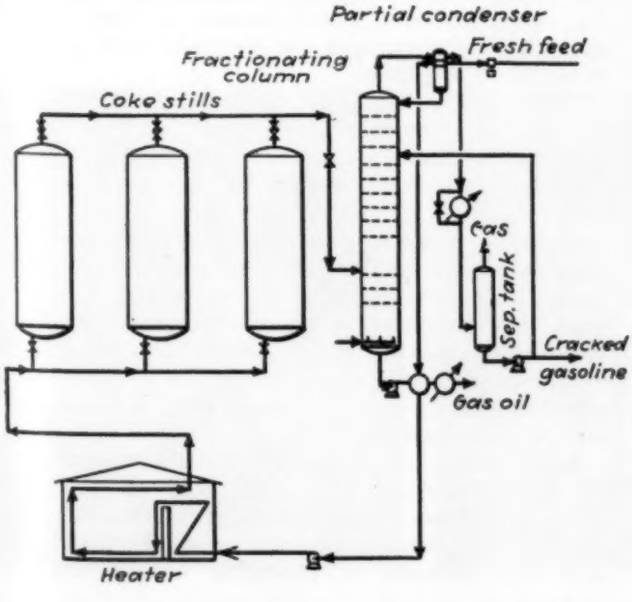
This processing of fuel oil is suggested to the gas man for the following reasons:

1. Readily available commercial charging material may be used.
2. The operation may be conducted so that the products are (a) water gas enriching material, (b) coke lump and coke fines, and (c) gas.
3. All products are immediately usable directly by the gas industry.

The accompanying diagram shows the simple relationship of the parts of such unit. If operated to produce 1,000 barrels per day of gas oil, such a unit would also make 130 barrels of gasoline, 13 tons of lump coke, a like tonnage of coke breeze, and enricher gas of 2200 Btu. per cubic feet of approximately 280 M cubic feet per day. This rich gas used with blue water gas would be equivalent to 160 barrels of gas oil per day in a plant ordinarily requiring three gallons of oil per M for carburetting.

The evaluation of heavy oil to be used in carburetting of water gas has long been a highly controversial question. Gradually there is evolving a system of oil appraisal which has wider acceptance. Although evidently far from final in form, the Terzian method of appraisal has aroused considerable interest. This method depends on the demonstrated fact that there is a constant relationship between the heat in the gas made and the sum of the generator-fuel and heavy-oil energy supplied. The Terzian factor, as this author proposes it, is calculated by adding together ten times the pounds per M of generator fuel and 100 times the gallons per M of oil and then dividing by the Btu per cubic foot of the make gas.

Heavy oil coking unit for processing of either crude or low grade fuel oil.



Industrial Gas Sales

Outstanding new industrial applications of both manufactured and natural gas have been developed. Perhaps most important of these during the past year has been the application of gas to air-conditioning units. Such usage is particularly advantageous for utility companies, which usually have lower demands on their system in the summer season.

To encourage industrial use, a large number of new types of control devices have been developed. The functioning of these enables precision operation of large equipment in process-industry appliances. Among the important functions of one such control device are the following: maintenance of a constant steam pressure under all load conditions, and maintenance of a constant gas-air ratio (CO_2) under all loads and under conditions of changing loads, changing gas pressures, and changing gas pressures due to barometric conditions, wind directions and stack temperatures. The average low-price control will not accomplish all of these things, but there are several in the higher-price field which will perform all of these functions with accuracy, providing burner equipment is properly sized and installed. In other fields of gas use, equally effective devices can be had.

Non-Sparking Tools Help Make Process Industries Safe

EDITORIAL STAFF SURVEY

PLANT SAFETY ENGINEERS in a number of different process industries were recently invited by *Chem. & Met.* to give their views on the use of non-sparking tools—especially in dangerous applications where flammable vapors or gases are handled. The replies reveal a wide variety of problems being solved by the use of such alloys as beryllium-copper and aluminum bronze. Some of the facts and figures—as well as personal opinions—obtained in this survey are summarized in the following paragraphs:

R. L. Rogers, safety director of the Tennessee Eastman Corp., states, "We use non-sparking tools extensively in our departments where there is a possibility of fire or explosion from the ignition of solvent vapors. Our stock includes machinist's hammers, sledge hammers, chisels, open-end wrenches, pinch bars, spatulas, and a few other odd items, all made of non-sparking metal. The metal does not stand up as well in service as most of the manufacturers claim. For a copper alloy it does stand up unusually well and is satisfactory for our purposes, but we cannot say that it is as good in service as steel.

"It is rather difficult to say whether these tools are actually worth the investment. Of course, if we did not think so we would not buy them. There is no way of counting the accidents and fires that do not happen. We have never had a fire caused by sparks from tools of any kind even prior to using non-sparking tools. However, the possibility of a serious fire or an explosion with an enormous potential loss of equipment, production and human life, makes us feel that we should take every possible safeguard within reason to prevent such a catastrophe."

Mr. Rogers continues with the citation of a Bureau of Explosives report of a case which clearly indicates the hazard of iron striking a spark in an explosive mixture: "Some men were attempting to clean out a tank car which contained gasoline vapors. Through the dome of the car they put a rubber air hose which had a steel pipe nipple on the free end. When the air was turned on the hose whipped, striking the nipple against the wall of the tank. This made a spark which exploded the tank car and killed four men. I do not know where this happened but it clearly indicates that a spark made by striking iron to iron will ignite flammable vapors."

Many of the replies describe typical uses in certain industries. Some experiences in the gas field are reported by S. C. Dickinson, safety engineer for the Pacific Gas and Electric Co., and B. G. Strong superintendent of pipelines for the Natural Gas Co. of America. Mr. Dickinson states, "Non-sparking tools are used in this company's gas department to minimize the possibility of an explosion or a fire while working in the presence of gas. We use hammers, scrapers, wrenches, picks, shovels, digging bars, and chisels. We do a great deal of our gas work 'hot,' and, of course, are continually caring for leaks. The use of such tools is a great safeguard against the hazard of fire or explosion. We believe the investment is justifiable." Mr. Strong adds, "We have had a few occasions where we have used non-sparking tools such as you mention. Although they are quite expensive, we are of the opinion that the expense is well worth the safety obtained for the workers at times when it becomes necessary to make repairs and changes on equipment where there is a gas hazard. We have used these tools particularly in connection with making repairs and pipe changes on our gas scrubbers."

Oil refineries, with only a couple of exceptions, state that they have been using non-sparking tools for some time, and with varying degrees of satisfaction. G. W. Smith, director of safety of the Standard Oil Co. of Indiana says, "For many years we have used non-sparking tools of various kinds with fairly good success, although we have found that these tools were not all-service equipment by any means. Being made of softer material than steel, we have found in the dismantling of equipment that wrenches often failed because of their lack of strength. For such work, we use steel tools well protected by oil or grease.

"We believe strictly in the use of non-sparking tools in such places as gasoline engine rooms, pump rooms handling highly volatile products, gasoline absorption plants, and plants handling propane and like products. The most successful of these tools have been open-end wrenches, scrapers, pinch bars, hammers and shovels. In addition to these, we find very good service received from screw drivers and chisels that are not required to do heavy work. In our opinion, a non-sparking tool is worth the investment made, taking into consideration the locations mentioned previously in this letter. We certainly cannot afford to create a spark that might cause a fire or explosion in those locations."

R. H. Waser, manager of the Wood River refinery of the Shell Petroleum Corp., reports trouble with pipe wrenches. "Lines and equipment which cannot be rendered gas-free are opened with non-sparking tools. We have had difficulty in procuring non-sparking pipe

wrenches with sufficient jaw-strength without increasing the size of the jaws to the extent that they are difficult to use. To prevent sparking with the regular steel wrenches, we apply heavy oil to the surface of the pipe. This necessarily means that the jaws of the pipe wrench must be in good condition." C. E. Wharton, superintendent of the Hanlon Gasoline Corp. of Texas tells of a method used by oil drillers to eliminate sparking. "It is more or less common practice around drilling rigs where there is gas present, to take a ball peen hammer and dip it in grease, which seems to eliminate the sparking."

The manufacture of photographic film involves many potential fire hazards. A. L. Armstrong, general supervisor of the department of safety and fire prevention for the Eastman Kodak Co. says, "We do use beryllium-copper tools, such as screw drivers, cold chisels, hammers, axes, and we have tried out some of the drills, but not too successfully. This equipment is used wherever we have flammable liquids or solids which could be ignited by striking a spark, and to date we have found them very satisfactory. In regard to the cost, it has always been our feeling that anything which would prevent an accident such as a fire or explosion was justified."

With only a few scattered exceptions, the rest of the replies indicated, as did those quoted here, that non-sparking tools are being used wherever there is a possible explosion hazard from flammable vapors.

Description of Properties

The non-sparking type of tool is relatively new. It was first introduced about fifteen years ago, but not until the last few years have manufacturers been able to offer in their tools an alloy having both the non-sparking property and the combination of hardness and resistance to shock and deformation which is required under most service conditions. Design has also been improved. Since these tools are all made of copper base materials, they must be correctly designed in order to give maximum service and durability. They are not mere duplicates of steel tools, for no copper alloy produced today has the strength of forged steels.

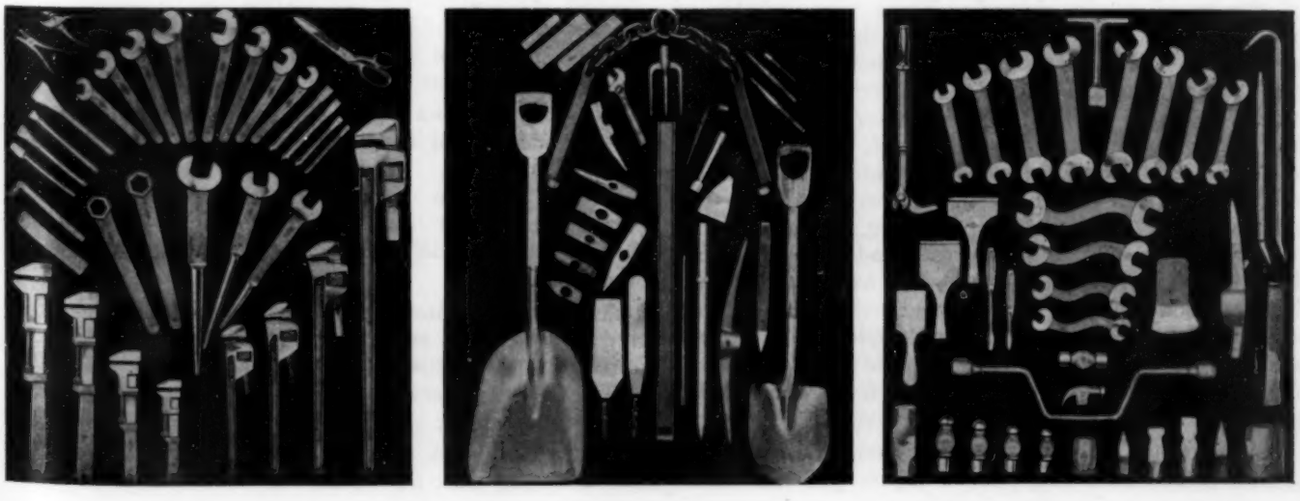
Of the two most common non-sparking alloys, aluminum bronze and beryllium-copper, the former is used most frequently in tools which do not have to withstand extreme service conditions. The aluminum bronze used in tools differs from the ordinary alloy of this type in that its hardness can be controlled without heat treatment through a brinell range of from approximately 100 to 350 points. The harder grades of the alloy, which are suited for cutting-tool service, are rather brittle and tend to spall under impact. Therefore, for articles such as hammers, wrenches and picks, a somewhat softer grade of metal which has greater toughness must be used.

Beryllium-copper is a much newer alloy and has been standardized in preference to aluminum bronze for certain tools such as scrapers and spatulas, which must have more resilience than can be obtained in the bronzes. Beryllium-copper is also preferred for tools which require both toughness and maximum hardness, such as drills, pipe wrench jaws, and chisels. An outstanding advantage of this alloy is the fact that it is hardenable by heat-treatment, a property which aluminum bronze does not have. Articles may be shaped and machined in the soft condition and then heat-treated to the desired strength and hardness. Some tools which do not require special design can be forged in the same dies used for steel if proper attention is given to the forging temperature, and allowance made for the slower flow characteristics of the alloy. A final heat treatment brings the alloy up to a brinell hardness of from 300 to 400 and a tensile strength of from 90,000 to 130,000 lb. per sq.in.

An indication of the comparative strengths of aluminum bronze and beryllium-copper is afforded by the results of a test, made by the Hinsdale Mfg. Co. of Chicago, on two open-end wrenches which were identical in all respects except the materials of which they were made. The jaws of the aluminum bronze wrench spread at 220 ft. lb. but took no permanent set until 350 ft. lb. were exerted. The jaws of the beryllium-copper wrench spread at 350 ft. lb. but withstood 400 ft. lb. before taking a permanent set.

Unfortunately, both beryllium-copper and aluminum bronze tools cost considerably more than steel tools. The price of a ball peen hammer made of aluminum bronze is almost twice that of a steel one, while the same thing made of beryllium-copper costs more than twice as much as the one of aluminum bronze. However, where human life is at stake, cost cannot be a determining factor.

Over 400 different types, styles and sizes of non-sparking tools find use in the process industries.



Cleaning Steel—Chemically

By RICHARD L. DAVIES

Pennsylvania Salt Manufacturing Co., Philadelphia, Pa.

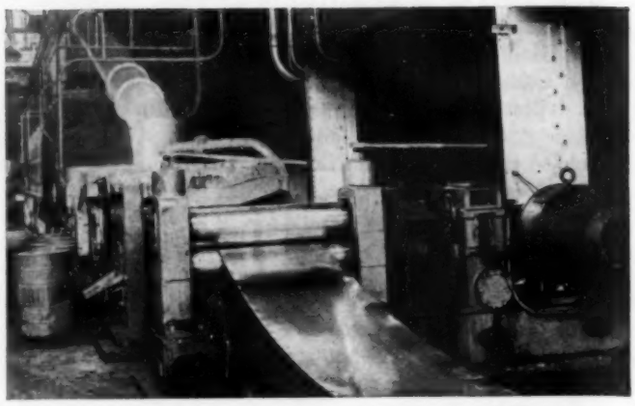
ADVANCES in the methods and materials used in the industrial cleaning of steel products are of twofold interest to chemical engineers. In the first place the effectiveness of the process has an important bearing on the application of protective coatings, films, and enamels used to resist corrosion in chemical industries. Secondly, the development of new and more efficient cleaning agents widens the market for a variety of chemical products. Such a new material is anhydrous sodium orthosilicate, which is rapidly finding its place among the industrial alkalis used for detergent purposes.

These chemical cleaning agents are principally the alkaline salts of certain weak inorganic acids—soda ash, trisodium phosphate and the four alkaline sodium silicates which are available as heavy chemicals. The latter include the hydrated sodium metasilicate, $Na_2SiO_3 5H_2O$; the anhydrous sodium metasilicate, Na_2SiO_3; the hydrated sodium sesquisilicate, $Na_6Si_2O_7 11H_2O$ and the new anhydrous sodium orthosilicate, Na_4SiO_4. The meta and sesquisilicates have their definite places in industry and are most widely used in cleaning non-ferrous metals and in other applications where a gentle detergent action is desired.

For what might be termed heavy-duty cleaning operations, such as the preparation of steel for the application of protective coatings, a very active detergent is required and it is here that solutions of the anhydrous sodium orthosilicate have proved most effective. But even the most efficient detergent can be greatly aided in its cleaning action by mechanical means. Brushes, wiping rolls, and pressure sprays are used for this purpose. Electrolytic machines have also been developed for cleaning everything from continuous strip steel at the rolling mills (see accompanying illustration) to paper clips in the shops of the fabricators.

In the electrolytic machine, cleaning is largely effected by the generation of small gas bubbles on the surface of the metal to be cleaned. These tiny bubbles of hydrogen or oxygen literally blast the adhering dirt loose from the steel and into the solution. Thus for this type of cleaning the higher the electrical conductivity of the detergent solution, the more uniform and thorough will be the action of the electric current. Tests made in our laboratories with solutions of various alkaline salts at a concentration of 3 per cent (4 oz. per gal.) and at a temperature of 200 deg. F. showed that the anhydrous sodium orthosilicate had a relative conductivity of 10.05 amperes at 6 volts as compared with 3.90 for soda ash, 3.25 for hydrated sodium metasilicate and 2.52 for hydrated trisodium phosphate. Amperage was measured between two 2 in. wide steel plates immersed in the solutions to a depth of 6 in. when placed 4 in. apart at a constant potential of 6 volts.

Solutions of a given concentration of anhydrous sodium orthosilicate also have a higher pH than solutions of the same concentrations of any of the other alkaline salts used in steel cleaning. Values for the same 3 per cent solutions are as follows: soda ash, 11.9; TSP, 12.3; metasilicate, 12.8; sesquisilicate, 13.3 and orthosilicate, 13.5. The pH of an alkaline solution is an indication of its dissolving and saponifying activity and as would be expected, solutions of anhydrous sodium orthosilicate are found in actual practice to have a more rapid dissolving effect on acidic and fatty types of soil than the other salts mentioned.



Electrolytic machine continuously cleaning strip steel, using anhydrous sodium orthosilicate

For economical use, an alkaline cleaning solution must also resist the tendency of acidic soil to lower its pH. In fact the working capacity or lasting power of a detergent is indicated by the quantity of normal sulphuric acid which can be added to a liter of 3 per cent solution before its pH drops to a point where the solution is no longer effective for detergent work. The minimum allowable pH value is assumed to be 10.0 in many cleaning operations. Such tests have shown that 544.8 c.c. of normal sulphuric acid can be added to a liter of 3 per cent anhydrous sodium orthosilicate solution as compared with 317.8 c.c. for hydrated sodium sesquisilicate, 181.1 c.c. for hydrated sodium metasilicate, 170.8 c.c. for soda ash, and 79.13 for the hydrated trisodium phosphate solution. Again experience in continuous plant operation has shown that solutions of a given concentration of this new chemical will remain effective longer than solutions of the same concentration made with the other salts.

Sodium orthosilicate is sometimes made more effective by the addition of small amounts of soda ash or trisodium phosphate. This is especially true where only very hard water is available. In cases where a greater emulsifying action is desired, this can be obtained by the addition of small quantities of various organic emulsifying agents.

Anhydrous sodium orthosilicate solutions are too active to be used in applications where they would come into continued contact with tin or aluminum. But for the cleaning of steel preparatory to the application of protective coatings and for many other heavy-duty detergent applications, this new chemical seems destined to take a leading place among the industrial alkalis.

Reader's VIEWS AND COMMENTS

That Reverse of Absorption

To the Editor of Chem. & Met.:

Sir:—In one of your recent issues there was a letter from F. H. Chapman of Trail, B. C., relative to his search for a word to express the reverse of absorption. Perhaps I can throw some light on this question for Mr. Chapman, since I, too, have found the use of the word "stripping" to be confusing when applied to so many phenomena other than the inverse of absorption.

No single word seems applicable to a restricted definition because of the difficulty in defining absorption. The latter term has such general meaning in so many diverse applications that the use of a single word for inverse absorption would likewise be as general and confusing as absorption itself.

For instance, to remove a fluid from a paste by casting in molds, utilizing capillary action of the mold, the art speaks of absorption. No chemical reaction taking place. Suppose that the mold is so fine that the capillary action is nil for the fluid in question but that a transfer of the fluid does take place. This is likewise absorption. As usually defined absorption may consist of mechanical transfer, transfer by chemical reaction either altering the reactor or leaving the reactor as in the original condition. The action may or may not be selective.

For these reasons the writer feels that instead of seeking for a word for inverse absorption we should seek to use several words—one for each restricted case. Stripping has become so general a word picture that it does not create the same thought to different persons.

Aside from the purely physical phenomena defined by absorption both absorption and its reverse are not separate phenomenon even though they may be selective as to direction. We do separate them by word or mathematical fiction to simplify consideration. In any case the continuity should be considered.

The so-called stripping of gases by liquids is a surface energy phenomena dependent upon the thermodynamic environment and in no way related to the absorption phenomena, if absorption is used in its original sense. Stripping in this case is a very descriptive word and any attempt to call it absorption or inverse absorption such as has been suggested at times will only add confusion. If stripping is to be reserved to some other art then a new word or two must be coined to describe the thermodynamic reorientation.

HUGH E. WEIGHTMAN

De Kalb, Illinois

"Eyes, But They See Not"

To the Editor of Chem. & Met.:

Sir:—Your editorial, "Eyes, but they see not," has inspired me to write to you in regard to 4th of July accidents. Just before reading the editorial I had listened to a friend who had witnessed the following accident: A little girl, about three years old was walking along the street holding her father's hand. A boy exploded a torpedo a few feet away. Some of the hot chemical shot squarely into the child's eye. Screaming with pain, she was rushed away in her father's arms, possibly to become the wearer of one of the 40,000 glass eyes that are imported each year, as your editorial describes.

Do we need the equivalent of another "And Sudden Death" to stir us to action toward preventing 4th of July accidents? True, it is only one day in the year. But who are the victims—innocent children, in most cases. And for what purpose? No one can point out a single benefit from the use of fireworks in the hands of children. Surely no one can urge the continuance of a chemical industry the products of which do no public good and cause needless suffering among innocent children. Of course, this does not apply to pyrotechnic displays conducted by competent people.

If *Chem. & Met.* really "yearns for and would be happy to participate in a drive for real eye conservation," would it not be proper for you to consider the fireworks industry as a point of attack? Safety, like charity, should begin at home—and the manufacture of fireworks is a chemical industry; the importation of them is likewise the concern of American chemical industry.

T. F. CORCORAN

Chemical Engineer

Washburn, Wisconsin

This One Is Being Traced

Editorial Note: An internationally known American professor of chemical engineering received this letter recently from the Academia de Sciencias e Artes of Rio de Janeiro. Such attempts to trade upon good will and international relationships should certainly be stamped out.

Mr. .....

Cordially yours.

As homage to your great technical merits and in gratitude to the services you have contributed to teaching in America, the Congregation of this Academy resolved to confere you a Diploma of Doctor in Chemistry, in Honoris-Causa.

We know that the United States is today the world's largest producer of chemical commodities and without boasting, the United States now can lay claim to a greater chemical industry than that possessed by any other country. I would be very happy to see you among us and I would also appreciated picture of yourself.

This Directions has confirmed this acts of high justice and has conferred you the Gold Medal of Merit.

Any further reply you may care to send, it will be warmly appreciated and I want to thank you for the kind attention given to this letter.

Cordially yours,

Secretary Director

P.S. Just a few lines to let you know that the cost of graduation with a Diploma, credentials and the Gold Medal of Merit is $10.00 (ten dollars) minimum.

If you can to send some donatif and books written by you for the patrimony of this Academy have the kindness to satisfy, I will be very thankful.

No Bill payable on order: SEND AMERICAN BANK NOTES, BY RETURN OR POST.

Secretary Director

Corrections for "Your Materials Handbook"

Unfortunately there were several important omissions from the tabulated lists of materials of construction published in the October issue of *Chem. & Met.* Our attention has been called to the fact that the J. Bishop & Co. Platinum Works of Malvern, Pa., was not included among the platinum producers listed on page 528. The G. Woolford Wood Tank Co., Pascall P. O., Philadelphia, should have been cited on page 562, among those who make wood tanks and pipes for chemical applications. The Fiberloid Corp., Indian Orchard, Mass., has asked to be listed on page 559 as the manufacturer of Fiberloid, a cellulose nitrate plastic, and Fibestos, a cellulose acetate plastic. On the same page, Carbide and Carbon Chemicals Corp. was incorrectly listed as Carbide and Carbon Chemicals Co. On page 527, the tensile strength figure for Special Acid Lead should have been 2.25 instead of 225.

THE EDITORS.

Chemical Engineer's BOOKSHELF

Chemical Rubber Handbook

HANDBOOK OF CHEMISTRY AND PHYSICS. 21st Edition. Edited by *Charles D. Hodgman*. Published by Chemical Rubber Publishing Co., Cleveland, Ohio. 2023 pages. Price, $6.

THE NEW EDITION of the Chemical Rubber Handbook again outdoes its predecessors in quantity and scope of information. Included in this volume are 175 pages of new and revised material.

In the mathematical section will be found a new arrangement of the numerical tables in which values to at least seven significant figures are given. These tables have been enlarged to include separate columns for square and cube roots of 10n and 100n. A table of haversines and considerable material on statistics has also been added to this section.

Of particular interest to chemical engineers will be the new and very complete collection of data on commercial plastics. The tables there cover a wide range of physical and chemical properties for the many different plastics on the market today.

Other new features include tables giving both the factors and their logarithms for the reduction of gas volumes to standard conditions, and a table of isotopes which has been revised to date.

An important section in the handbook is the table of physical constants of over 5500 organic compounds named and arranged by Dr. Austin M. Patterson in accordance with the rules of the Committee on Organic Nomenclature of the International Union of Chemistry. An empirical formula index of these compounds is also given.

Non-Ferrous Metals

MODERN USES OF NON-FERROUS METALS. Edited by C. H. Mathewson. Published by American Institute of Mining and Metallurgical Engineers, New York City. 427 pages. Price, $3.

OUTSIDE of the textbook field, it is infrequent that one comes across a metallurgical book which is not written for and from the point of interest of the trained man in this field. Here, however, is an exception. Put in understandable language, yet retaining a technical appeal and giving the reader credit for some knowledge of scientific terms, the book presents the non-specialist with an enlightening survey of the entire non-ferrous realm. The less familiar alloying elements used in steels are covered, as well as the common non-ferrous base metals and their various combinations. Twenty-one contributors have united their efforts in covering the more important phases of historical development, metallurgical properties, methods of treatment and scope of application of each element and its alloys. The authors are to be commended on their careful selection of material to fill these few pages on so broad a subject.

A Chemical Autobiography

CATALYTIC REACTIONS AT HIGH PRESSURES AND TEMPERATURES. By *V. N. Ipatieff*. Published by the Macmillan Co., New York City. 786 pages. Price, $7.50.

Reviewed by *Norman W. Krase*

WITH THE GROWING complexity of the chemical literature, research workers find it helpful to have books that summarize the literature in specialized fields. To be really valuable, such books should be complete records, including results of investigations without regard to geographical location or national boundaries. It must, therefore, require exceptional circumstances to justify the publication of a "chemical autobiography" containing largely the work of one man. Such a book is Ipatieff's. The reviewer, nevertheless, feels that publication will be welcomed by chemists and chemical engineers because of the outstanding contributions of the author, his unique position both as a pioneer and present worker in pressure research, and finally his identification with the recent important industrial developments in catalytic polymerization of olefines.

Ipatieff's work is divided into twelve chapters. The first two deal with reactions of alcohols; four chapters discuss phases of hydrogenation of many organic substances. Condensation, polymerization, and alkylation are the subject matter of others. An interesting discussion of theoretical principles for catalytic reactions furnishes the author an opportunity for critical analysis of current ideas in this fruitful and debatable field.

Chemical engineers, particularly in the petroleum industry and related activities utilizing natural hydrocarbons, will be well repaid by reading Ipatieff's contribution to knowledge in this very rapidly developing subject. An unusually complete subject index enhances the value of the book for reference purposes. A foreword by Professor Willstaetter touches the high points of the author's career.

Processing the Cottonseed

MECHANICAL PROCESSING OF COTTONSEED. By *W. R. Woolrich* and *E. L. Carpenter*. Published by Engineering Experiment Station, University of Tennessee, Knoxville, Tenn. 154 pages.

PRIOR TO the initiation of the research work which led to the preparation of this book, most of the attention of research investigators in the field of cottonseed utilization had been directed toward the treatment of the oil after it had been expressed, rather than toward efficient processing of the seed itself. Through the interest of an organization of cottonseed oil superintendents and the later interest of the American Society of Mechanical Engineers, a committee to investigate mechanical processing of the seed was formed in 1932. The active work of the investigation was carried out by the authors who looked into the history, economics and processes of the cottonseed oil industry and made a thorough study of the characteristics of the seed and oil. In this volume they have discussed the cleaning of cottonseed, the design of seed houses, and the equipment for the preliminary operations of delinting, hulling, separating and rolling. Experiments in rolling and in cooking of the cottonseed meats are described and conclusions advanced. The book is brought to a close with a description of the equipment used for forming and pressing the seed. An extensive and exhaustive bibliography on all phases of seed and oil treatment is included.

Chemurgic Proceedings

PROCEEDINGS OF THE SECOND DEARBORN CONFERENCE OF AGRICULTURE, INDUSTRY AND SCIENCE. Published by Farm Chemurgic Council, Dearborn, Mich., and The Chemical Foundation, Inc., New York City. 409 pages. Price, $0.50.

THIS COMPLETE transcript of the proceedings of the Second Dearborn

Conference will prove a valuable record to those who are interested in the present plight of American agriculture and are concerned with furthering the farmer's course through closer relationship between agriculture and chemistry. The volume includes complete reproductions of the 51 papers presented, together with discussion and comment.

THE CHEMISTRY OF THE COLLOIDAL STATE. By *John C. Ware*. Published by John Wiley and Sons, Inc., New York City. 334 pages. Price, $3.75.

THE FIRST edition of this book has been revised and rewritten, and new chapters added, without changing the nature of the book. It is still an introductory text. It has one advantage in that evidence and fact come before theory—which, after all, is in the colloid field only a summary of fact. The book has several disadvantages, chief of which is that references to original work are almost completely absent.

CHEMICAL SYNONYMS AND TRADE NAMES. By *William Gardner*. Published by D. Van Nostrand Co., Inc., New York City. 495 pages. Price, $12.

THE chemist and chemical manufacturer and salesman who is attempting to keep straight in his mind the ever-increasing list of chemical synonyms and trade names will find an invaluable aid in this book. As reviewers and users of the earlier editions have stated, its exhaustive list of commercial names makes it an extremely handy and dependable ready reference. The present edition has been brought up to date to include approximately 25,000 definitions and cross references in the field of chemical raw materials, minerals, explosives, dyestuffs, alloys, pharmaceuticals and commercial chemicals.

BROWN'S DIRECTORY OF AMERICAN GAS COMPANIES. Published by Robbins Publishing Co., Inc., New York City. 621 pages. Price, $20.

STATISTICS of gas companies in the United States and Canada have been brought up to date in this 1936 edition of Brown's Directory. The work needs no introduction, and its value as a reference and source book is well established. Notable among the changes in the new edition is a complete rearrangement of the manufactured, butane and natural gas sections. The material which was formerly included in these three sections has been combined according to a joint geographical and alphabetical layout, thus showing at a glance all companies serving gas in one locality. Developments in the gas industry during the year 1935 have resulted in a number of changes in the individual listings.

GOVERNMENT PUBLICATIONS

Documents are available at prices indicated from Superintendent of Documents, Government Printing Office, Washington, D. C. Send cash or money order; stamps and personal checks not accepted. When no price is indicated pamphlet is free and should be ordered from bureau responsible for its issue.

Paper Pulp From Cereal Straws by a Modified Sulphate Process, by Baker Wingfield and others. Bureau of Standards Miscellaneous Publication 124; 5 cents.

X-Ray Protection. Bureau of Standards Handbook HB20; 5 cents.

Supplementary List of Publications of the National Bureau of Standards, Jan. 1, 1932, to June 30, 1936; 5 cents.

Asphalt. Bureau of Standards Simplified Practice Recommendation R4-36; 5 cents.

Classification of Iron and Steel Scrap. Bureau of Standards Simplified Practice Recommendation R58-36; 5 cents.

Directory of Commercial Testing and College Research Laboratories. Bureau of Standards Miscellaneous Publication M125; 15 cents.

Paints. Bureau of Standards mimeographed series on Technical Information on Building Materials for Use in the Design of Low-Cost Housing, as follows: Paint Pigments—White, TIBM-30; Paint Pigments—Black, Red, and Lakes, TIBM-31; Paint Pigments—Yellow, Brown, Blue, Green, and Bronze, TIBM-32; Painting of Ferrous Metals, TIBM-28; Federal Specification Paint Pigments and Mixing Formulas, TIBM-33; Federal Specification Ready-Mixed Paints, Semipaste Paints and Mixing Formulas, TIBM-34; Preparation of Paints From Paste and Dry Pigments, TIBM-35; Preparation of Paints from Semipaste Paints, Thinning Ready-Mixed Paints, and Preparation of Water Paints, TIBM-36.

Corrosion of Ferrous Metals Underground. Bureau of Standards TIBM-29; mimeographed.

Willing-to-Certify Sources of Supply of Commodities Covered by Selected Federal Specifications and Commercial Standards—Mimeographed lists for the following industries: Softwood, lumber and timber manufacturers, wholesalers and retailers; brooms and brushes; chemicals, cleaning and polishing materials; coal and products, coal tar and products, and insulating materials; ceramics, furniture, glass and glassware, and hardware; office paste, leather, inks and paper; instruments, machinery, pipe and pipefittings, scales and tools; minerals and products; metals and metallic products; cordage and textiles.

Machine Placement of Fertilizers for Snap Beans in Florida, by G. A. Cumings and others. Dept. of Agriculture Circular No. 399; 5 cents.

Effect of Artificially Drying Seed Cotton Before Ginning on Certain Quality Elements of the Lint and Seed and on the Operation of the Gin Stand, by Francis L. Gerdes and Charles A. Bennet. Department of Agriculture Technical Bulletin 508; 10 cents.

Yearbook of Agriculture, 1936. Department of Agriculture; $1.25 (cloth-bound), 1189 pages.

Report on the Agricultural Experiment Stations, 1935, by J. T. Jardine and W. H. Beal. Department of Agriculture unnumbered document; 15 cents.

Revised Estimates of Flaxseed Production, 1866-1929, *and Acreage and Yield Per Acre*, 1899-1929. Bureau of Agricultural Economics; mimeographed.

The Effectiveness of Various Arsenicals in Destroying Larvae of the Japanese Beetle in Sassafras Sandy Loam, by Walter E. Fleming and Francis E. Baker. Department of Agriculture, Reprint from Journal of Agricultural Research, vol. 52, No. 7, April 1, 1936; 5 cents.

Apparatus for Placing Test Lots of Insects Within Parcels of Stored Tobacco During Fumigation Experiments, by W. D. Reed and others. Bureau of Entomology and Plant Quarantine ET-83; mimeographed.

Flour-Mill Insects and Their Control, by G. A. Dean and others. Department of Agriculture Circular No. 390; 5 cents.

Insect Parasites and Predators of Insect Pests, by Curtis P. Clausen. Department of Agriculture Circular 346; 5 cents.

Dyes and Other Synthetic Organic Chemicals in the United States, 1935. Tariff Commission Report No. 115, Second Series; 15 cents.

Plate Glass. Tariff Commission Report No. 110; Second Series; 5 cents.

Concessions Granted by the United States in the Trade Agreement With Switzerland. Tariff Commission unnumbered document; mimeographed, 286 pages.

Concessions Granted by the United States in the Trade Agreement With the Kingdom of the Netherlands. Tariff Commission unnumbered document; mimeographed, 232 pages.

Commercial Treaties and Agreements of the United States, in Force June, 1936. Tariff Commission; mimeographed.

Supplement to Second Edition of Printed Pamphlet Entitled Changes in Import Duties Since the Passage of the Tariff Act of 1930. Tariff Commission Release September 15, 1936; processed.

Digest of Customs and Related Laws and of Decisions Thereunder: Vol. 1, Dutiable and free lists—a compilation of certain general tariff acts and a digest of rulings and decisions thereunder, with reference to or citation of related laws, pages 1-1149; Vol. 2, special and administrative provisions, pages 1149-1899; Vol. 3, Index, pages 1901-2372. Set of three volumes, $4.00.

Mineral Production Statistics for 1935—mimeographed statements from Bureau of Mines giving the required corrections to Minerals Yearbook, 1936, on—Lime; by-product sulphuric acid at copper and zinc plants.

Electrometallurgical Investigations, by J. Koster and others. Bureau of Mines R. I. 3322; mimeographed. Contains three separate articles as follows: Electrolytic deposition of metallic manganese; Treatment of low-grade chromites to make an alloy acceptable to the steel industry; Recovery of potash and alumina from Utah alunites.

Extent and Availability of Natural Gas Reserves in Michigan "Stray" Sandstone Horizon of Central Michigan, by E. L. Rawlins and M. A. Schellhardt. Bureau of Mines Report of Investigations 3313; mimeographed.

Natural-Gasoline Plants in the United States, Jan. 1, 1936, by G. R. Hopkins and E. M. Seeley. Bureau of Mines Information Circular 6897; mimeographed.

Review of Literature on Effects of Breathing Dust With Special Reference to Silicosis, Part III-B, Chapter 5, Economic and Legal Aspects of Dust Disease in Industry (Sections 3 and 4), by D. Harrington and Sara J. Davenport. Bureau of Mines Information Circular 6892; mimeographed.

Permissible Electrically Operated Air Compressors, by L. C. Ilsley and others. Bureau of Mines Report of Investigations 3309; mimeographed.

The New Bureau of Mines Southern Experiment Station at the University of Alabama, Tuscaloosa, Ala., by Milton H. Fies. Bureau of Mines Information Circular 6903; mimeographed.

Petroleum Refineries, Including Cracking Plants, in the United States, Jan. 1, 1936, by G. R. Hopkins and E. W. Cochrane. Bureau of Mines Information Circular 6906; mimeographed.

Cooperative Fuel Research Motor-Gasoline Survey, Winter 1935-1936, by E. C. Lane and A. J. Kraemer. Bureau of Mines Report of Investigations 3311; mimeographed.

Handbook of Foreign Currencies. Bureau of Foreign and Domestic Commerce Trade Promotion Series No. 164; 20 cents.

Production Statistics From 1935 *Census of Manufactures* in preliminary mimeographed form. These are now beginning to appear for the various industries.

Geologic Literature on North America, 1785-1918, by J. M. Nickles. U. S. Geological Survey Bulletin 746, Reprint 1936; $1.25.

Glossary of Important Power and Rate Terms, Abbreviations, and Units of Measurement. Federal Power Commission unnumbered pamphlet; 5 cents.

Education Qualifications in the Engineering Profession. Bureau of Labor Statistics Serial No. R. 400; 5 cents.

Acute Response of Guinea Pigs to Vapors of Some New Commercial Organic Compounds, Part IX, Pentanone (Methyl Propyl Ketone), by W. P. Yant and others. Public Health Service Reprint No. 1739; 5 cents.

News of EQUIPMENT

Moving Pipe Conveyor

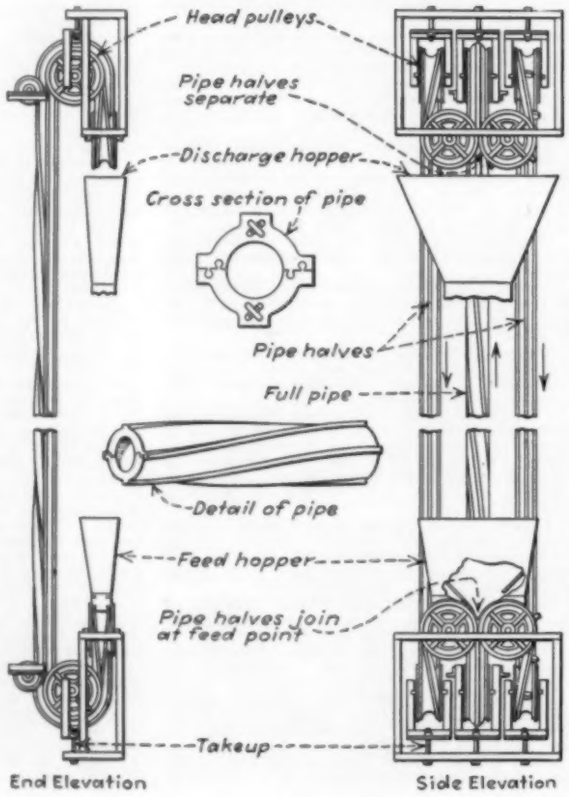
What is perhaps the most novel departure in conveyor design that has been announced in many years is the new Johns conveyor recently announced by the Johns Conveyor Corp., 605 Broad St., Newark, N. J. This system employs what is, in effect, a moving rubber pipeline which travels with the material from the feed point, in any direction and through as many changes of direction as desired, to the discharge point. Although the conveyor is intended primarily for solids, it can also be used to advantage in some cases for handling liquids, because, since the pipeline is divided into compartments by partitions at frequent intervals, when carrying a liquid its internal pressure is no greater at the bottom of a 1,000-ft. vertical lift than it is at the top.

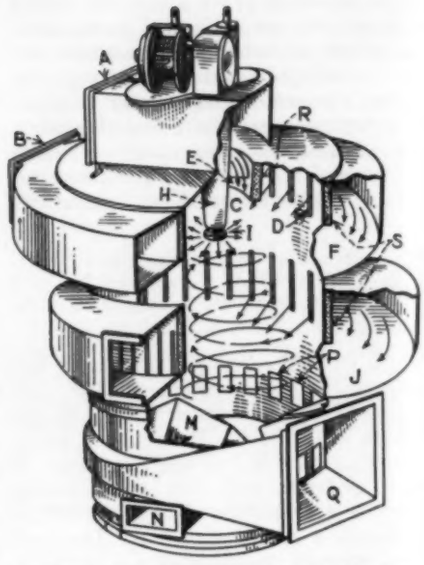
The essential element of this system is a flexible rubber pipe which is made in two half-sections as shown in the detail in the accompanying illustration. These two half-sections are readily separated by pulling apart, but are joined together with double tongue and groove joints during conveying, being held tight by a slight twist which is put in the pipe by the conveyor pulleys. One of the two half-sections contains partitions at frequent intervals so as to assist in picking up a full load when passing through a feed hopper. These partitions also avoid slipping and packing of the material on vertical lifts.

The new system is capable of picking up material from hoppers which may be located at one or more points along its line of travel. It is stated to convey without rubbing or tumbling the material, and hence with a minimum of breakage and dust. It is claimed to be absolutely noiseless, to transmit no vibration, to require little power on account of low friction losses and to resist corrosion by most chemical elements. It is resistant to abrasion and will not stain or discolor material. The conveyor sections can be washed and sterilized continuously, if desired.

The method is recommended by its makers for the handling of both dry and wet solids, as well as liquids on high lifts. It has already been demonstrated for more than two years in Canada, handling such products as raw sugar, and spillage coal at a coke plant. It is available in sizes ranging from 2 to 12 in. diameter of the pipe, capable of handling from 6 to more than 1,000 tons per hour of 100 lb. material.

Typical set-up of new moving pipe conveyor, with details of pipe construction





Cutaway view of new unit spray chamber

Unit Spray Dryer

Bowen Research Corp., Garwood, N. J., has recently announced improved equipment for spray drying, which may also be used in certain processes combining spray reaction and drying. The new unit spray chamber is illustrated herewith. It operates as follows: Hot air enters at *A* and *B* and passes into the chamber proper through the radial inlets indicated at *C* and *D* respectively. That entering at *C* is given a swirling, clockwise motion by means of the sloping passages at *E*. The hot air entering at *B* passes through the manifold *F* to vertical inlet nozzles *G*, so arranged as to direct their flow just to the left of the axial center of the chamber, thus producing, in combination with the air entering at *C*, a violent central vortex, closed at the top by the air entering at *C*.

The liquid, containing the solid to be dried, is admitted to the spray machine *H* at the bottom of which is the homogenizing atomizer *I*, which discharges a horizontal sheet of spray into the vortex of hot gases. Owing to the way the air currents are introduced into the chamber, spray is said not to reach the side walls and roof of the chamber.

Directly below the manifold *F*, which carries the hot air, is the manifold *J* carrying cold air. This is used in case of products requiring cooling before discharge from the apparatus. Cold air is introduced in the same clockwise direction so as to avoid eddy currents and disturbances. The spray, as it spirals downwards, loses moisture by evaporation and the solid particles produced are carried by the air currents through the ports *P* and the discharge *Q*. Particles reaching the floor are swept upward into the air current by a rotating air sweeper

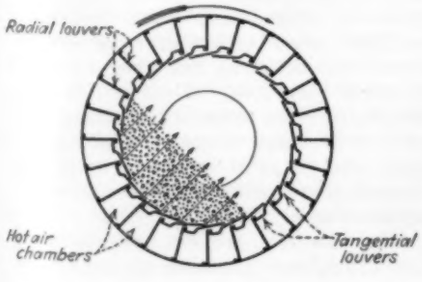
M which is driven by air supplied through port *N*. Aluminum foil insulation for the internal surfaces of the chamber subject to the temperature of hot gases is provided as at *R* and *S*.

In addition to the new unit spray chamber, the company has developed new centrifugal atomizing equipment, both electric and steam driven, and a new closed type of homogenizing atomizer which is stated to produce thorough homogenization of any mixed materials that are fed to it. Depending on requirements, these atomizers are driven at speeds as high as 18,000 r.p.m. Owing to the fine division produced and the intensive action possible between gases, liquids and solids, this equipment is also recommended for carrying out such reactions as the removal of sulphur dioxide from flue gases by means of milk of lime, or weak ammonia solutions containing a catalytic agent; the making of sodium sulphate and hydrochloric acid through reaction of sulphur dioxide and sodium chloride sludge; or the reaction of potassium hydroxide and carbon dioxide.

Rotary Louver Dryer

Manufacturing and sales rights in North America for the Dunford & Elliott rotary louver dryer, of which many installations have been made in Europe, Canada and Japan, have been secured by the Link-Belt Co., 300 West Pershing Road, Chicago, Ill. This dryer, which is intended for the drying of all types of granular materials, both coarse and fine, may be described briefly as a mechanically rotated horizontal drum with a series of internal channels near the circumference, into which hot air is forced by a fan. These channels are covered by tangential plates which overlap in such a way that they leave a gap for hot air to pass from the channels into the material, at the same time preventing the material from falling backward into the air passages. The hot air connection is so made that, as the drum revolves, only those channels which come underneath the charge are connected with the hot air supply and all gases must pass upward through the bed of material.

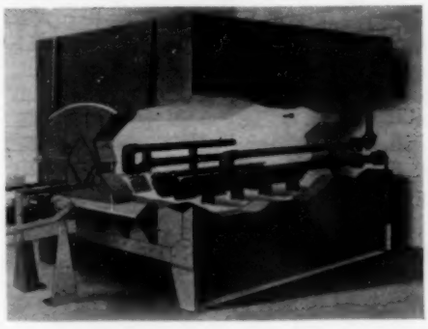
Schematic cross section of rotary louver dryer



Employing cold instead of hot air, the dryer has also been used as a cooler. Either as a dryer or cooler, it is claimed to give highly efficient heat transfer and uniform results. It is available in a wide variety of sizes.

Radiant Tube Furnace

Through cooperation between the Surface Combustion Corp. and the Ferro Enamel Corp., Cleveland, Ohio, an improved form of gas-fired furnace for porcelain enameling has been developed and is being installed by the latter concern in porcelain enamel plants. The heating element, which is available for installation in both new and old furnaces, consists of a series of hair-pin shaped tubes placed on the hearth and side walls of the furnace. The gas fuel burns in the tubes with a nonturbulent flame, and never in contact



Phantom view of radiant-tube furnace

with the ware being fired. As the tubes are under negative pressure, contamination of the firing chamber atmosphere by combustion gases is eliminated.

The new design is claimed to insure uniform temperature distribution and accurate heat control. Should a tube fail, ready replacement is possible. Although the initial cost of the new equipment is said to be somewhat high, its high efficiency and the improved quality resulting are stated to more than warrant the investment in practically all cases.

Novel Still

Olympic Products, Ltd., 2120 Belgrade Ave., Huntington Park, Calif., announces the introduction of the Lea still, a device said to employ a new method of distillation and a new type of equipment adaptable to a wide range of liquids and sources of heat. Essentially, the new still involves a source of heat, surrounded by evaporating means, in turn surrounded by condensing means. The liquid is evaporated in a thin, shallow ribbon, traveling rapidly through a thin metal channel surrounded on three sides by heat and open on the fourth side to the condensing chamber. The vapors leave the channel and immediately enter a zone of lowering temperature where they condense and fall as a rain. The heat of condensation is transferred in the condensing section to the entering liquid, preheating it on its way up to the channel.

Applied to the distillation of water, the new still is said to require a gross heat input of 1,318 B.t.u. and a total raw water supply of 7.14 lb. per pound of distilled water produced. For each 7.14 lb. of raw water used, the still produces 1 lb. of distilled water and 6.14 lb. of hot, sterilized water.

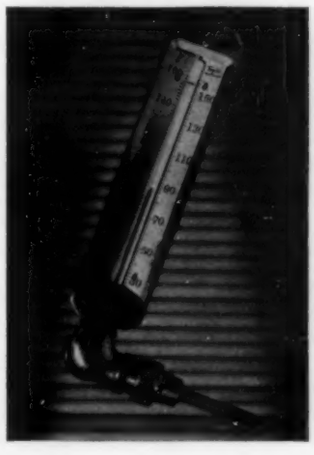
In the water still, the cold raw water under regulated pressure enters the lower end of a copper coil which is tinned outside and shaped as a rectangular spiral. Absorbing heat from the surrounding steam the raw water is practically at boiling point when it reaches the upper end of the coil and here the contained gases are vented to the atmosphere. From the coil the raw water enters the channel, which is also arranged as a continuous rectangular spiral, traveling downward by gravity until it is discharged at the bottom.

Improved Industrial Thermometer

Notable improvement in the ease of reading is said to have been effected by the new Binoc thermometer tubing now being employed by the Taylor Instrument Cos., Rochester, N. Y., in industrial thermometers. The new tubing combines more than twice the usual angle of vision, with high magnification of the mercury column. The column, owing to the optical characteristics of the tubing, is said to stand out in sharp relief.

This concern has also introduced an improved, streamlined hydrometer, the principal feature of which is the method

Industrial thermometer with wide-angle visibility



employed for assuring permanent accuracy of the scale. The scale is of lightweight metal, fused into the alloy weighting material. The name of the new hydrometer is Permax.

Dust Counter

With the increasing interest in elimination of dust hazards, particularly silicosis, simplified means for determining actual dust concentration have become of greater importance. To permit dust counts to be made easily and accurately without extensive laboratory training and experience, the Bausch & Lomb Optical Co., Rochester, N. Y., has developed a new dust-counting instrument which combines in one unit the necessary air sampling device and dark-field

New simplified dust counter

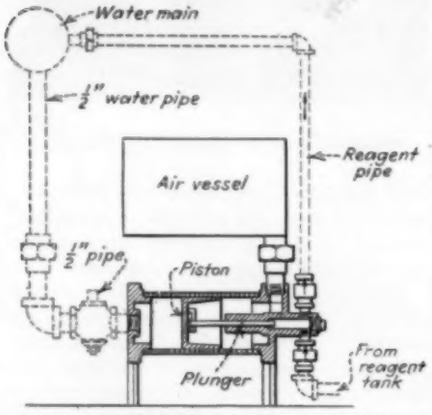
microscope viewing and counting system. The necessary illuminating apparatus and transportation case are provided. Air is drawn into the instrument through a moistening chamber by means of an accurately calibrated hand pump. The dust particles are impinged on a circular glass plate in the instrument and twelve samples may be collected on one slide. The samples may be counted at once without removal and preserved for future reference simply by sealing with a cover glass. The apparatus is so calibrated that a count of the dust particles in certain small specified areas, multiplied by 100,000, gives the total dust count per cubic foot. The instrument can also be used for classifying the particles by size.

Plastic Packing

"Super-Seal" is the name of a new anti-frictional plastic packing that has recently been added to the line of the Crane Packing Co., 1800 Cuyler Ave., Chicago, Ill. This is a general, all-service packing, containing a new dry-graphite lubrication originated by this company. In addition the material contains a great number of fine metallic particles of a new low-friction alloy, together with strands of long-fiber asbestos covered and saturated with a special high temperature binder, containing the graphite. The material is said to be resilient, never to get hard and never to dry out. It is available in bulk, in spiral and coil form, in ring form and as small cords for valve stem packing.

Automatic Silicate Feeder

Development of the Series W Mixitt, an automatic silicate feeder for the elimination of rusty water in building water systems, has been announced by John S. Watts, 116 Prospect St., East Orange, N. J. This device is operated by variations in water pressure and consists as is shown in the accompanying cross section, of a plunger to feed the silicate solution into the water line, actuated by a piston in contact on one side with the water main pressure and on the other side with a balancing air cushion. The device is readily adjusted by changing the opening of the cock connecting the water main with the cylinder.

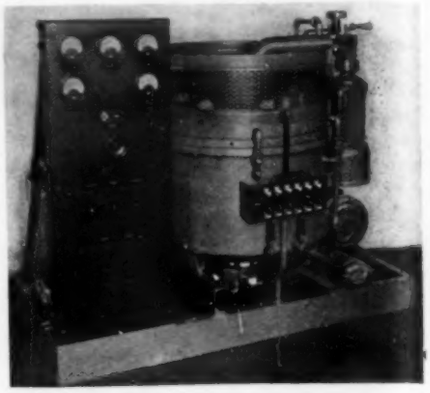


Cross section of new silicate feeder

Acid-Resisting Pumps

Worthite, a new high-nickel, high-chromium molybdenum alloy steel, containing not over 0.07 per cent carbon, and said to be absolutely stainless and not subject to intergranular corrosion, has been employed by the Worthington Pump & Machinery Corp., Harrison, N. J., in the construction of a new line of small centrifugal pumps available in 1 and 1½ in. sizes. All parts of the liquid end of this pump are of Worthite, while acid-resistance for other parts is obtained by using specially treated steel coated with Tornesit chlorinated rubber.

The impeller is of the open type with three vanes opening down to the hub. With this construction, the stuffing-box is subject only to suction pressure. These pumps will handle heads up to 70 ft. and have capacities to 130 gal. per minute.



New low-capacity, low-voltage rectifier

Low-Voltage Rectifier

A simplified, low-capacity, low-voltage, grid-controlled mercury arc rectifier, which is completely assembled at the factory, has been announced by Allis-Chalmers Mfg. Co., Milwaukee, Wis. The new rectifier is available with a rating of 150 kw. at 250 v. and 300 kw. at 550 v., direct current. The set, including the rectifier tank, all auxiliaries and the control panel, is assembled and wired on a common frame occupying a floor space only 3½x6 ft. It is recommended for all industrial uses where a small amount of direct-current power is required for special drives or processes.

Constant Viscosity Oils

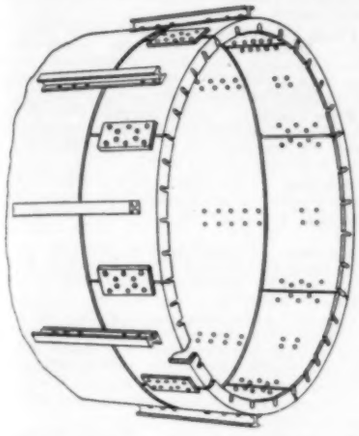
To provide oils suitable for use under a wide range of atmospheric temperatures, the Standard Oil Co. of New Jersey is offering, through the sales engineering division of Esso Marketers, 26 Broadway, New York City, a new series of all-petroleum oils having a viscosity index of 150, said to be the highest yet offered. The new materials, branded as Univis, contain no added chemicals. The high viscosity index is said to make them particularly suitable for uses where constant viscosity is necessary. They are adapted to such uses as in hydraulic control apparatus, platform scale dash pots, hydraulic variable speed equipment and instruments subjected to extremes in temperature variations. Their use is said to eliminate the necessity of using oils of two or three viscosities during the year, and to avert increases in power consumption when colder weather thickens other oils.

The new oils are not recommended for equipment operating at practically

constant temperatures throughout the year. They are available in 1 and 5 gal. cans and larger quantities, and in viscosities above 100 Saybolt sec. at 100 deg. F.

Kiln Nose Ring

Warpage and distortion such as may be encountered with solid end rings in rotary kilns are said to be completely eliminated by a new field-tried alloy kiln end nose ring recently announced



Eight-segment alloy kiln end nose ring

by the American Manganese Steel Co., Chicago Heights, Ill. This end ring, which is made in all sizes, consists of eight segments, each made with ample expansion and contraction spaces on the seal lip and held together by butt straps bolted on through slotted holes to eliminate twisting. The whole assembly is supported from the main kiln shell by means of rigid I-beams. The Amsco alloy used is said to be completely resistant both to the extreme temperatures and the corrosive action of sulphurous gases.

Flexible Cable

Extreme flexibility and durability are said to be outstanding features of the new "Powerduct" cable for industrial use, recently put on the market by Anaconda Wire & Cable Co., 25 Broadway, New York City. This cable, recommended especially for use on equipment that may have to be relocated, is said to be highly resistant to mechanical abuse as well as to deterioration by petroleum products. It contains three rubber-insulated, seven-strand conductors and one bare ground conductor, carefully cabled, wrapped and protected. The outer covering is treated to be both moisture resistant and flame retarding.

Another Anaconda subsidiary, American Brass Co., has in recent years been experimenting with the use of corrosion resisting materials for the production of electrical conduits to be employed in chemical plants. The company has recently announced the successful completion of its work and the commercial introduction of Everdur metal conduits which have a strength comparable to that of steel plus slightly better corrosion resistance than copper. This alloy of copper, silicon and manganese, is now made into two types of conduit both of which have been passed by the Underwriters Laboratories. One type, a lighter tubing, is available in sizes from $\frac{3}{8}$ to 2 in. The other, a more rigid conduit, is supplied in nominal sizes from $\frac{1}{4}$ to 4 in.

Electric Level Switch

McDonnell & Miller, Wrigley Bldg., Chicago, Ill., has recently developed a simple float-operated switch for the checking or control of liquid level. The working mechanism consists of a mercury switch inside a float which is attached to a head by means of a flexible metallic bellows. As the float moves through its arc, the mercury switch makes and breaks contact. The head of the unit is provided with threads which can be screwed in a horizontal position directly into a tank or vat at any desired height. Thus a very simple mechanism is provided for sounding an alarm, lighting a warning light or starting a pump or other device.

Motor Operated Timer

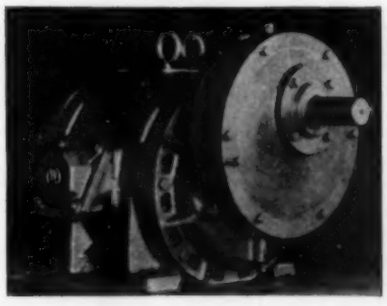
Several motor operated timing devices have recently been added to the line of timing devices of other sorts manufactured by Struthers Dunn, Inc., 139 North Juniper St., Philadelphia, Pa. One is of the immediately recycling type, using a synchronous motor to drive cams through a train of gears. At the time the starting impulse is received, the motor starts and a solenoid is energized to operate a clutch which connects the cams to the motor. At the end of the cycle, the motor is de-energized by a contact on one of the cams, the clutch holding the cams in position. As soon as the solenoid is de-energized, the cams are returned to the starting position by a spring. Timing is widely adjustable.

In another type, the timer rotates continuously, the cams being made to rotate at any desired speed by means of gears. The contacts can be made to close for any time up to half the time required for one revolution if timing is adjustable, or if not adjustable, up to a complete revolution.

Explosion-Proof Motors

A new line of single-reduction, explosion-proof gearmotors, ranging in size from $1\frac{1}{2}$ to 75 hp., has been announced by Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. These motors are adaptable to uses in Class 1, Group D hazardous locations where speed reduction is required. The gears are of the single-helical type, heat-treated, and built to carry the maximum torque the motors will develop. Anti-friction bearings are provided to assure high efficiency and maintain correct gear center distances. These motors have been approved by the National Board of Fire Underwriters, and are acceptable for use with such products as petroleum fractions, alcohols, etc.

Single-reduction gearmotor for hazardous locations



MANUFACTURERS' LATEST PUBLICATIONS

Air Conditioning. Carrier Corp., 850 Frelinghuysen Ave., Newark, N. J.—A. I. A. File No. 30-F-1—16 pages on this company's air conditioning, refrigeration and space heating equipment for industrial and other purposes.

Air Conditioning. Consolidated Air Conditioning Corp., 114 East 32d St., New York City—7-page book on odor-absorption equipment made by this company.

Alloys. International Nickel Co., 67 Wall St., New York City—Bulletin P-1—14 pages on properties and applications of heat-treated wrought nickel alloy steels.

Alloys. Republic Steel Corp., Republic Building, Cleveland, Ohio—New series of booklets describing this company's stainless steels, including a book of general nature, one on 18-8 steels, one on the straight chromium type, one on heat-resisting types and one on 4-6 per cent chromium steels.

Aluminum. Aluminum Co. of America, Pittsburgh, Pa.—Form AD 117—60 pages on mechanical, chemical and electrochemical finishes for aluminum.

Chemicals. Glyco Products Co., 148 Lafayette St., New York City—44 pages on organic chemicals produced by this company, with information on uses, including formulas.

Chemicals. Hercules Powder Co., Wilmington, Del.—Form 566—6 pages on the use of ethyl cellulose as a pigment grinding base.

Chemicals. Hunkins-Willis Lime & Cement Co., 4480 Duncan Ave., St. Louis, Mo.—8 pages on precipitated calcium carbonate, U. S. P., sold by this company and made by Peerless White Lime Co.

Chemicals. R. F. Revson Co., 91 Seventh Ave., New York City—8-page price list and catalog covering small lots to 50 lb. of chemicals, principally those used in cosmetics and pharmaceuticals.

Chemicals. Technical Service Bureau, Inc.,

6805 North Clark St., Chicago, Ill.—17 pages on this company's organic chemical products and their applications.

Construction Materials. Johns-Manville Corp., 22 East 40th St., New York City—60-page book illustrating and describing this company's industrial products including insulating materials, refractory cements, flooring, wall and roofing materials, pipes, gaskets and electrical products; also 26-page book simply describing industrial roof construction.

Crushers. Traylor Engineering & Mfg. Co., Allentown, Pa.—Bulletin 3627—42 pages with descriptions and engineering data on this company's crushing rolls.

Detergents. Pennsylvania Salt Mfg. Co., Widener Bldg., Philadelphia, Pa.—Leaflet describing Orthosil, a new heavy duty alkaline detergent (anhydrous sodium orthosilicate).

Detergents. Philadelphia Quartz Co., Philadelphia, Pa.—Bulletin 511—8 pages on this company's product, Metso 99, a sodium sesquisilicate detergent.

Diatomite. The Dicalite Co., 120 Wall St., New York City—16-page booklet on this company's product, Dicalite, and its use as an inert in paint, varnishes, lacquers and enamels.

Doors. Cornell Iron Works, Inc., 3600 15th St., Long Island City, N. Y.—8-page catalog describing rolling doors and shutters, hand and motor operated, made by this company.

Dust Collection. American Foundry Equipment Co., 535 Byrkit St., Mishawaka, Ind.—Data Book 22—24 pages on this company's Dustube dust collector with engineering information on dust control.

Equipment. Allis-Chalmers Mfg. Co., Milwaukee, Wis.—Bulletin 1263—8 pages on this company's dryers and coolers for granular materials; Bulletin 1479, 12 pages on centrifugal vibrating screens.

Equipment. Cochrane Corporation, 17th St. and Allegheny Ave., Philadelphia, Pa.—Bulletin 2059—12 pages completely describing this company's deaerating type hot-process water softener; also Catalog 2534, 26 pages describing numerous sizes of the Creasey ice-breaker.

Equipment. General Ceramics Co., 30 Rockefeller Plaza, New York City—16 pages on this company's chemical stoneware laboratory sinks and accessories.

Equipment. Hardinge Co., York, Pa.—Bulletin 39-A—Discusses this company's countercurrent classifiers with information on applications and operating data.

Equipment. Patterson Foundry & Machine Co., East Liverpool, Ohio—4-page folders describing this company's Unipower agitators and processing kettles.

Equipment. Standard Machinery Co., Mystic, Conn.—Leaflet briefly describing preforming and self-contained molding presses made by this company.

Equipment. F. J. Stokes Machine Co., Olney P. O., Philadelphia, Pa.—22-page folder illustrating a variety of tablet-making machinery including mixers, dryers, mills, tablet machines and coating pans.

Equipment. Worthington Pump & Machinery Corp., Harrison, N. J.—Bulletins as follows: W-205-B2, covers types and applications of this company's steam-jet ejectors; W-318-B5A, two-stage volute centrifugal pumps; W-323-B1A, automatically primed centrifugal pumps; W-621-B1A, steam-driven, direct-acting, air-cooled air compressors.

Electrical Equipment. Durakool, Inc., Elkhart, Ind.—Leaflet describing this company's liquid-filled metal mercury switches.

Electrical Equipment. Fairbanks, Morse & Co., 900 S. Wabash Ave., Chicago, Ill.—Bulletin E-100-B—48-page "Electric Machinery Catechism," containing 144 questions on electricity and its application, with comprehensive answers, including many drawings and other illustrations.

Explosives. Atlas Powder Co., Wilmington, Del.—Bulletin 245—44 pages on more than 100 different grades of dynamite and a wide variety of this company's blasting accessories.

Filters. Oliver United Filters, Inc., 33 West 42d St., New York City—Bulletin 122-A—4 pages describing this company's leaf pressure filter for polishing and clarifying liquids.

Frits. Porcelain Enamel & Mfg. Co., Baltimore, Md.—8-page folder briefly describing results in enamel frit manufacturing attained with this company's new continuous smelting process.

Furnaces. Ajax Electrothermic Corp., Trenton, N. J.—Bulletin 10—24 pages describing this company's oscillator or spark-gap type electric converters and furnaces with information on construction and uses.

Glass. Corning Glass Works, Corning, N. Y.—16-page book presenting, with many illustrations, certain highlights in this company's recent activities, including production of fibrous glass and materials made from it.

Hard Facing. Colmonoy Co., Los Nietos, Calif.—12-page booklet describing Colmonoy No. 6, a nickel-base hard-facing alloy for resistance to corrosion and abrasion.

Heat Exchangers. Griscom-Russell Co., 285 Madison Ave., New York City—Bulletin 1611—8 pages describing heat exchangers using this company's G-Fin tubing.

Heat Transfer. Dow Chemical Co., Midland, Mich.—36 pages on Dowtherm heat transfer media with complete information on properties and uses, tables of engineering information, and data on calculation of heat transfer coefficients.

Instruments. American Meter Co., 60 East 42d St., New York City—Handbook E-4—212-page bound book on the measurement of gases by positive displacement meters, including information on gases, types of meters, meter testing and repair. This book is offered by the publishers in quantities at a price of $3 per copy.

Instruments. The Bristol Co., Waterbury, Conn.—Bulletin 436—Covers a new line of round-chart recording voltmeters and ammeters; Bulletin 460T, describes this company's new system of coordinated process control for automatically operating all technical operations and factors of an industrial process.

Instruments. The Brown Instrument Co., Philadelphia, Pa.—Catalog 6703—72 pages on this company's indicating, recording and controlling thermometers and pressure gages; Catalog 8901, 32 pages describing this company's air-operated controllers for temperature, pressure, flow and liquid level, showing also principles of operation.

Instruments. Cambridge Instrument Co., Ltd., 45 Grosvenor Place, London, S.W.1, England—6-page leaflet describing this company's indicating and recording electrical distance thermometers.

Instruments. Charles Engelhard, Inc., Chestnut St. and N. J. R. R. Ave., Newark, N. J.—5-page folder describing principle and applications of this company's portable thermal conductivity gas analyzer.

Instruments. Esterline-Angus Co., Indianapolis, Ind.—Bulletin 836—4-page article describing the application of graphic instruments on beaters, pumps, coal pulverizing and other paper mill equipment.

Instruments. Julien P. Friez & Sons, Inc., Baltimore St. and Central Ave., Baltimore, Md.—15-page catalog on air conditioning control instruments for temperature and humidity; also 16-page catalog on instruments for air conditioning and weather determination and recording.

Instruments. Leeds & Northrup Co., 4901 Stenton Ave., Philadelphia, Pa.—Folder 160—Briefly illustrates this company's measuring instruments and automatic controls for power plant use; also Bulletin 709-C, 16 pages on automatic pH control for improved clarification of raw cane juice.

Instruments. Mine Safety Appliances Co., Pittsburgh, Pa.—Bulletin DU-2—4 pages on this company's improved methane detector.

Level Control. McDonnell & Miller, Wrigley Bldg., Chicago, Ill.—Catalog 36—32 pages covering numerous types of liquid level control made by this company.

Lime. United States Gypsum Co., Industrial Sales Dept., 300 West Adams St., Chicago, Ill.—48-page book on lime with information on production and uses, with particular reference to applications in building construction, industry and agriculture.

Lubricants. Gulf Oil Corp., Pittsburgh, Pa.—Form 570—20-page pictorial description of this company's lubrication research.

Materials Handling. American Engineering Co., Philadelphia, Pa.—4-page leaflet briefly describing this company's Lo-Hed monorail and stationary hoists.

Materials Handling. Lewis-Shepard Co., 175 Walnut St., Watertown, Mass.—Folder 225—Leaflet of 6 pages describing numerous types of industrial floor trucks; Folder 506, illustrates hand and powered portable cranes.

Mixers. Mixing Equipment Co., Rochester, N. Y.—Catalog B-53—24 pages on a variety of portable and permanently attached mixers and agitators made by this company.

Oil Seals. Garlock Packing Co., Palmyra, N. Y.—40-page book completely describing and listing engineering data on this company's Klozure oilseals.

Optical Equipment. Bausch & Lomb Optical Co., Rochester, N. Y.—Publications as follows: D-139, optical control for paper technologists; D-188, 4 pages on dust-counting equipment; E-240, research metallographic equipment; F-19, low-power photomicrography.

Ovens. Despatch Oven Co., 622 Ninth St., S. E., Minneapolis, Minn.—Section A5—Leaflets portraying and briefly describing finish baking and drying ovens for a variety of products.

Pigments. Krebs Pigment & Color Corp., Wilmington, Del.—Handbook of white pigments, describing zinc sulphide and titanium dioxide pigments with data of value to pigment users.

Pipe. American Rolling Mill Co., Pipe Sales Division, Middletown, Ohio—Bulletin 236—39 pages with data, completely describing this company's spiral welded pipe for oil and gas industry use.

Pipe Coatings. The Barrett Co., 40 Rector St., New York City—80-page spiral bound book on application of this company's pipe line coatings in the field.

Plastics. Synthane Corp., Oaks, Pa.—6-page folder on grades and properties of this company's laminated synthetic plastic tubing.

Plastics. Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.—Bulletin 2063—28-page booklet describing industrial applications of Micarta.

Plates. Abbé Engineering Co., 50 Church St., New York City—Leaflet briefly describing and giving specifications of conical-hole perforated plates offered by this company.

Power Transmission. Morse Chain Co., Ithaca, N. Y.—48-page catalog on this company's stock drives.

Power Transmission. Reeves Pulley Co., Columbus, Ind.—Leaflet describing six types of control applicable to this company's variable speed transmissions.

Power Transmission. Chas. A. Schieren Co., 30 Ferry St., New York City—6-page folder briefly illustrating and describing this company's leather transmission belting.

Pumps. Allen-Sherman-Hoff Co., Lewis Tower, Philadelphia, Pa.—Catalog 836—24 pages on this company's Hydroseal sand pumps with removable rubber linings and impellers.

Pumps. DeLaval Steam Turbine Co., Trenton, N. J.—9-page reprint of article on economics of water pumping with particular reference to securing economies through speed control of centrifugal pumps.

Pumps. Fairbanks, Morse & Co., 900 S. Wabash Ave., Chicago, Ill.—Bulletin 555—16-page book on this company's close-coupled centrifugal pump with integral motor drive.

Pumps. Ingersoll-Rand Co., 11 Broadway, New York City—Bulletin 7066—16 pages of engineering data on Cameron coupled centrifugal pumps.

Refrigeration. Carbondale Machine Corp., Harrison, N. J.—Bulletin 1104—16 pages explaining the absorption method of refrigeration and giving detailed information on this company's equipment.

Refrigeration. York Ice Machinery Corp., York, Pa.—Bulletin 36,146—16 pages on this company's vertical, single-acting, inclosed ammonia compressors.

Separators. Stearns Magnetic Mfg. Co., Milwaukee, Wis.—Bulletin 700—Describes this company's K-type separators for magnetic separation of materials of low magnetic susceptibility.

Stokers. Link-Belt Co., 2410 West 18th St., Chicago, Ill.—Book 1619—24 pages on automatic industrial stokers in capacities to 300 hp.

Tannic Acid. E. D. Bullard Co., 275 Eighth St., San Francisco, Calif.—Leaflet describing "Kip-Tannic," a water-soluble jelly containing 5 per cent tannic acid for use in burns and scalds.

Waxes and Resins. American Cyanamid & Chemical Corp., 30 Rockefeller Plaza, New York City—16-page booklet on properties and uses of waxes; 40-page booklet with data and tabular material on properties and uses of natural resins.

Welding. Lincoln Electric Co., Cleveland, Ohio—Bulletin 412—24 pages on arc-welding technique with particular reference to this company's dual continuous control as applied to the new "Shield-Arc S. A. E." welder.

Chemical Engineering NEWS

Power Show Exhibits Will Occupy Three Floors

THE Twelfth National Exposition of Power and Mechanical Engineering will be held in New York, during the week of Nov. 30 to Dec. 5. Three floors of Grand Central Palace will be occupied and admission will be by invitation or by registration only. Operating exhibits will be featured and the equipment on display will range from power producing equipment, factory machinery and industrial equipment to materials of construction and plant accessories.

Engineers interested in fuel economy will find many helpful exhibits in the instrument section. Among the items exhibited will be automatic draft and overfire pressure controllers, flow meters, carbon dioxide and stack temperature recorders, recording thermometers and pressure gages, remote boiler water level indicators, and combustion safeguard equipment. A new line of furnace pressure regulators will be equipped with throttling range and automatic reset adjustments designed to maintain draft or over-fire pressure at predetermined value, irrespective of load. A dual air-operated control thermometer to be exhibited will be of interest to the air conditioning and drying fields because it represents both wet and dry bulb temperature control in a single instrument. Control systems are independently adjustable and throttling range of each may be varied while the instrument is in operation.

There will be a number of exhibits devoted to motorized speed reducers and the transmission section will feature roller chains, ball bearings, flexible couplings, and gears. Ratiomotors will be shown in various types and sizes, ranging from one-twentieth to three horsepower, and in ratios from seven and one-half to one up to 5,040 to one. Shown also will be improved jaw couplings designed to remove strain between motor and the machine which it drives.

Of interest to many fields, including the fabricators of synthetic plastics will be an exhibit of seamless flexible metal hose and fittings. In the same field, self-flaring copper tube fittings will be featured with the claim that they eliminate the use of flaring tools. Exhibits of flexible metal hose and fittings will be designed for such fields as railroad, air conditioning, airplane, chemical, and diesel engine; also for a variety of presses, hydraulic and steam.

Machine tool exhibits will include high speed and heavy duty metal sawing machines, some with hydraulically operated bar feed. In this classification, machines will be exhibited capable of cutting solid bars of steel at the rate of from three to ten square inches per minute, depending on the size and kind of steel being cut. Sawing equipment will include metal cutting band saws and a new double rotary saw designed for high production. The metal cutting saws are described as self-contained, simple, flexible, convenient, and highly adaptable. In a related field, one exhibitor will demonstrate the latest models of cut-off machines, grinding wheels and pneumatic grinders.

Tariff Commission Plans Chemical Surveys

CHEMICAL DIVISION, U.S. Tariff Commission, is planning a number of chemical surveys and reports. The surveys will include nitrogen, sodium sulphate, glue and plastics, starches and dextroses, synthetic resins, petroleum and petroleum products, and alkaloids.

In addition to these surveys the division is occupied with the initial steps in connection with possible investigations and digests of projected trade agreements, especially the one with the United Kingdom. In all of the agreements Uncle Sam has made with foreign countries the division has had much to do, digesting concessions made by this country, and collecting and studying other phases of the agreements affecting the chemical industry.

Work of the division has been under the direction of Dexter North since 1930, when Mr. North became acting chief of division succeeding Warren Watson. Mr. North is a graduate of Hamilton College, where he took his B.S. degree in chemical engineering.

R. H. Cragg, who acts as assistant chief in the absence of Mr. North is in charge of the work with oils, fats, starches, dextrines, paints, varnishes and alcohol. Working with him is Raymond G. Webb, who specializes in cellulose plastics, glues and jellies, barium products, mineral acids, certain organic chemicals, vulcanized fibers, bone char and activated carbons. W. F. Sterling, who has been with the division for several years, handles pigments, phosphate fertilizers and some other chemicals, while P. K. Lawrence looks out for the coal tar products, perfumes, dyeing and tanning (vegetable) materials, extracts and the like, and R. N. Lawrence is responsible for alkaloids, bleaches, magnesium compounds, manganese compounds, chromium compounds, cobalt, polishes and crude drugs. Felix Stapleton is in charge of the work with soda and potash, including fertilizers, nitrogen fertilizers and aluminum compounds.

W. D. Bell, who has charge of the work with petroleum and petroleum products had long years of intensive experience with a number of oil companies before entering the service of the Government.

Carbon Dioxide Industry Requests Trade Conference

APPLICATION for a trade practice conference for the carbon dioxide industry in the United States has been filed with the Federal Trade Commission. Application for the conference was made to the Commission by the Carbon Dioxide Institute, Inc., with offices at 75 East 45th St., New York, pursuant to the action of the executive committee of the Institute, which recently adopted a resolution directing the president of the Institute to make application to the Federal Trade Commission "for the authorization of a trade practice conference of the carbon dioxide industry, and to cooperate with the Federal Trade Commission on behalf of this Institute to promote the success of such trade practice conference."

There are nearly 30 members of the Institute engaged in the manufacture of carbon dioxide, either in liquid or solid form, which is approximately one-half the number of firms in the country engaged in such production. Volume of sales of carbon dioxide for the entire industry in 1935 approximated $9,500,000. The industry has invested capital approximating $25,000,000, and employs about 1,500 workers.

NEWS FROM WASHINGTON

Washington News Bureau
McGraw-Hill Publishing Co.
Paul Wooton, Chief

INTERNATIONAL questions of importance to the chemical industry now dominate much of the Washington situation. Officials are more than ever impressed with the world influence on domestic enterprise. This fact has been brought home especially by the girdling of the globe on commercial transport agencies in about 18 days by an enterprising reporter. In effect, the world has shrunk. This fact must be taken into account in industrial planning.

More tariff adjustments are confidently expected during the coming year. It is definitely known, though not officially admitted, that data are being gathered and analyzed with respect to commodities that might be considered in negotiations with Great Britain. Many such changes in chemical tariffs would, of course, be of great importance to the chemical industry. It is too early to say just what commodities will be considered; but almost anything can happen in the course of this work, and probably will.

Tax Revision

Only a miracle can in any way importantly modify the obligation of corporations on March 15 to report undistributed earnings and pay surtaxes thereon. Even the most optimistic probusiness enthusiasts of Washington do not hope for modification of the tax law of 1936 in time to aid on March, 1937, returns. November, therefore, is practically a last call for policy decisions of chemical companies as to how much of the anticipated total earnings of the year will be distributed to stockholders. The regulations of the Treasury, which have the effect of law, of course, make extra dividends as *pre*-Christmas presents essential if they are to be credited on tax exemptions.

The real battle over this question will come between the philosophies of RFC Chairman Jesse Jones and Treasury-Watchdog Henry Morgenthau. The lender likes to get back his loan, and Uncle Sam is no exception. The tax collector wants generous returns to the Treasury, even if RFC loans are not quite so readily paid off. The White House must ultimately referee the battle between these philosophies.

More Price Fixing

Confusion as to the meaning of the Robinson-Patman law grows. It seems likely that no real clarification can come about through administrative rulings. Decisions of the courts are necessary not only to guide business in observance, but quite as much to guide the officials in attempted enforcement.

Representatives of industry in the National Capital are therefore welcoming the series of court tests which have been initiated by the commission. The cases on which the commission has sued business were very carefully selected to test important principles of the law and determine ultimately by final court action what are the rights of government in this matter of price-supervision. It will be months before any of these cases can reach ultimate decision in the Supreme Court. In the meantime the Federal Trade Commission is expected to watch out for violations, and presumably it will prosecute any management that appears unwilling to give reasonable cooperation in law observance. No flood of court cases is expected.

Perhaps the most disturbing cloud on the price horizon is the forecast of Rep. Patman that he intends to press legislation in the next session forbidding retail sales by manufacturers. Many believe that such legislation would not be constitutional, if enacted; but the spirit back of such a proposal may affect much legislation in the next few years. It is, therefore, rightly a matter of deep concern to all divisions of business, even those apparently not affected by present or proposed laws.

Clay Beneficiation

Cooperation between Tennessee Valley Authority and the U. S. Bureau of Mines on clay beneficiation gives promise of early commercialization of kaolin occurrences near Spruce Pine, N. C. The nonmetallics investigators of the Bureau, working at the Tuscaloosa station, are encouraged in their attempt to remove the small quantities of iron and mica by flotation methods. Preliminary results indicate that a very high grade porcelain or china can be made from treated clays by the electric-kiln methods proposed.

Preliminary results have recently been reported by the ceramic engineers of TVA at a meeting of Electrochemical Society. The new continuous electrically heated ceramic kiln for high temperature burning has been demonstrated on a quasi-commercial scale. Enthusiastic forecasts are therefore being made as to the possibility of new nonmetallic mineral utilization in the Southeastern States, based on these recently identified occurrences of high-purity kaolin and the supplies of cheap power available nearby. Some enthusiasts even forecast a large increase in domestic china and porcelain making, minimizing English and other European imports. Others have limited their enthusiasm to forecasting a supplanting of the imported clays by these American supplies.

Uncle Sam, Buyer

Many controversies still rage over the legal status of labor provisions in the Walsh-Healy Act regulating Government purchases. Perhaps the most disputed feature of the first set of regulations released by Secretary of Labor Perkins in September is the definition of open-market purchases. Most persons had previously assumed that any commodity commonly bought in the market by competitive bids was so purchased. The Department of Justice rejected the idea and ruled that unless the Government purchasing agent could make such a purchase *without taking bids* it was not an "open market" transaction within the meaning of the law.

To the surprise of many, the important Government purchasing offices expected to oppose the regulations are finding them of substantial aid in doing business exclusively with the more responsible contractors. The sweat-shop type of operator is, of course, greatly handicapped; and even the petty "chiseler" has some difficulties in successfully bidding. The real test of the sentiment of Government purchasing offices will come later. It will undoubtedly prove that this act increases the average cost of certain commodities to the Government. Appropriations hitherto adequate will then be insufficient. It takes no keen imagination to anticipate intra-Government controversies that may put to shame present wails of established contractors.

It should not be expected that rigorous application of this act is likely at all soon to occasion much wage fixing for industry. Months of field investigation must precede any important findings. This does not in any way suspend the nominal effect of the law, but it does at least cushion, perhaps for a year, the impact on wage contracts which some feel will ultimately be superseded in part by rulings of the Secretary of Labor.

Gas Men Hold Hard-Working Convention

GAS MEN in goodly numbers carried out the usual elaborate program of meetings, exhibits, and social events at Atlantic City the week of Oct. 26 under the joint sponsorship of the American Gas Association and its affiliate Association of Gas Appliance and Equipment Manufacturers. It was evident throughout the meetings and from lobby conferences that there is great confidence both in the well being of the associations and the future of the industry. This happy sentiment is well supported by the official report of 100,000 new household customers acquired by the industry in the first eight months of 1936 and the reported sales increases to industry of 21 per cent in natural gas and 11.6 per cent in manufactured gas, as compared with the first part of 1935.

The exhibit of equipment and appliances, assembled after a two year interval, was a very well dressed show, although somewhat smaller than usual in floor area and in number of exhibitors. The attendance, breaking no records, was very gratifying, because it was made up so largely of serious studious visitors, and a negligible number of mere sight-seers and window-shoppers. Engineers of production, distribution, and utilization are looking for dollar-saving ideas.

It was notable that in every case increased numbers of accurate control instruments and devices are being offered, with increased acceptance. New methods of manufacture though relatively few in number represented real advances, and improved materials of construction for both works and utilization appliances were generously approved.

Three medal awards were announced at the convention. L. J. Willien, widely known operating engineer of Public Utilities Service Corporation, Chicago, received recognition in the Charles A. Monroe award, given for the outstanding contribution of the year to the general interest of the industry. He was cited for his "rational and consistent research, success in a number of applications, generosity of contributions, originality and usefulness to the industry, in the field of advanced processes for manufacturing, mixing and transmitting gas."

Another of the conspicuous honors given annually by A. G. A. is the Beal Medal. This year it was presented to George E. Hicks, superintendent of distribution, of the gas department, of the Central Hudson Gas and Electric Corporation, Poughkeepsie, N. Y. This award was based on the most important technical paper given before the association or any of its subdivisions during the past year, an article entitled "Experience in Leak Proofing Bell and Spigot Joints."

The third medal recognized heroic action by George L. Creely, gas distribution superintendent, Public Service Electric and Gas Company, Somerville, N. J., in averting a serious fire which threatened to take many lives and destroy property.

The new officers who will serve the Association for 1937 will be headed by the well-known popular engineer, Herman Russell of Rochester Gas and Electric Corporation, Rochester, N. Y., advanced from the position of first vice-president. N. C. McGowen, was also advanced from second to first vice-president, and Conrad N. Lauer, president of the Philadelphia Gas Works Company, named second vice-president. Work of the technical section of the coming year will be under M. I. Mix, Chicago, as chairman with J. V. Postles, Philadelphia Gas Works Company, as vice-chairman. The industrial gas section will be headed by Ralph L. Manier, Syracuse Lighting Company, and Hale A. Clark, Detroit City Gas Company, as chairman and vice-chairman, respectively.

New Solvents and Resin From Light Oil Refining

A BROAD study of the refining of light oils at byproduct coke plants is being carried on at Mellon Institute of Industrial Research, Pittsburgh, Pa. P. J. Wilson, Jr., and J. H. Wells, who are in charge of this work, have recovered from the residues several new products, including a series of high-boiling oils and a dark stable resin, which can be produced in large quantities at low cost.

The high-boiling oils are largely aromatic hydrocarbons with small proportions of paraffins and compounds soluble in 80 per cent sulphuric acid. These oils are said to possess excellent solvent properties. They are solvents for rosin and resinates, many natural gums, a large number of synthetic resins, rubber and chlorinated rubber, and "Thiokol." Sulphur and paraffin are dissolved to a limited extent in the cold. The oils are miscible with most of the commercial organic solvents, and are not affected by water, brine, alkalis, or dilute mineral acids.

The new resin is apparently a mixed polymer of cyclic dienes and aromatic olefin compounds. The resin is soluble in many commercial solvents, including the aromatic hydrocarbons, drying oils, and chlorinated hydrocarbons.

London Congress for Testing Materials

FOR those interested in concrete, natural stones and ceramic materials the Congress of the International Association for Testing Materials, which is to be held in London in April next will be of considerable importance. The subjects to be discussed are divided into four groups, metals, inorganic materials, organic materials, and subjects of general importance, each of which is presided over by a distinguished worker from overseas. The group, which covers concrete, natural stones, and ceramic materials, has Prof. E. Suenson of Denmark, as president, and an inspection of the preliminary list of papers which are to be presented indicates that the treatment of the different subjects will be most comprehensive, as the papers originate in some eleven different countries. Among the subjects included under concrete are the testing of aluminous cement and plastic mortars, the development of heat by cement, seawater cements, water-proofing compounds, the creep of concrete under load, vibrated concrete, cement pipes, and the strength of reinforced concrete beams.

The last Congress for Testing Materials was held in 1931, and every effort is being made to insure that the knowledge in this most important field will be brought completely up to date. It is of interest to note that the papers will be presented in the form of summaries, so that a vast amount of information will be made available in easily accessible form. Further details relating to the Congress will be published as they become available.

Specifications for Standard Carboy Bottles

MANUFACTURING CHEMISTS' ASSOCIATION on Manual sheet C-3, has announced specifications for the MCA standard carboy bottle. This bottle is being adopted rapidly by the entire chemical industry, and reports indicate that the new bottle is a great improvement over those formerly employed.

The specifications provide for two types, one with plain mouth and one with ground mouth and vented or unvented ground-in glass stopper. The capacity of the new bottle is 13 U.S. gals., weight 22 lbs. minimum. The glass must be light green and resistant to action of ammonium hydroxide, nitric, sulphuric and hydrochloric acids.

Marking on the bottles include initial or symbol of manufacturer on bottom, the initials "M.C.A.STD." gallonage and year of manufacture.

GERMANY'S MOTORIZATION PROGRAM AND SYNTHETIC MOTOR FUEL AND RUBBER

FROM OUR GERMAN CORRESPONDENT

WITH increasing difficulties due to foreign exchange and the resulting scarcity of imported raw materials, the German government's motorization program is taxing the resourcefulness of industry in supplying synthetic motor fuels and rubber. The new "4-year plan" announced at the Nürnberg party congress indicated the government's intention to direct production toward greater independence of foreign raw materials. On Sept. 27 in opening the thousandth kilometer of the newly constructed highway system, Hitler announced that within 18 months Germany could be completely independent of imports in supplying her own motor fuels and rubber.

Compared with the United States the degree of motorization in Germany is low, with one automobile per 65 persons of the population as against an average of one for every 5 persons in America. The millionth automobile in Germany was registered only last year. Strenuous efforts are being made, however, to stimulate automobile manufacture, production approximating 200,000 cars in 1935 as compared with 175,000 in 1934 and 128,000 in 1929. The motorization program, partly as employment creation and partly as rearmament, also provides for a new national highway system of 4,000 kilometers, 1,000 of which have just been completed.

Of the total 2 million metric tons of motor fuel consumed in Germany in 1935, 1,218,000 tons was imported. If the demand for all foreign raw materials in Germany were normally fulfilled for 1936, a theoretical deficit of 1,000 million RM would result, unless the foreign trade balance shows a decided improvement. The export surplus during the first 8 months of 1936 amounted to 245 million RM compared to a favorable balance of 288 million RM for the last 6 months of 1935. Unless German exports can be increased, the production of which again often requires the importation of foreign raw materials—in August 214 million RM of raw materials and semifinished goods was imported as against 343 million RM finished goods exported—this deficit must be made up by cutting down imports and effecting savings wherever possible through going over to domestic production.

Germany's natural petroleum resources are low, supplying only one-ninth in 1934 and one-eighth in 1935, of domestic consumption. Some 127 plants supplied 430,000 metric tons of crude oil in 1935, and unless additional wells are found, production from this source by the end of next year can hardly be increased over 450,000 tons. Since coal is one of the few raw materials found in abundance in Germany—Germany was the third largest coal producer in 1935, and the world's largest lignite producer with 71.8 per cent of the world's production,[1]—and since the high commercial gas production involves considerable coke (normal gas-coking yields 4 per cent coal tar, low-temperature coking 8 to 10 per cent) it is natural that extensive attempts are being made to obtain motor fuels through hydrogenation and low-temperature coking processes, using coal, lignite and coal tar.

When the plants for making synthetic motor fuels which are now under construction have been completed, Germany's annual production capacity by the end of 1937 should be approximately as follows:[2]

	Production, 1935 (in 1,000 metric tons)	Capacity End of 1937 (in 1,000 metric tons)
Light Motor Fuels:		
Synthetic gasoline from lignite	230	900
Synthetic gasoline from anthracite	...	250
Benzol in coking- and gas-works	400	410
Alcohols — methyl and ethyl	180	250
Liquid gases — propane, butane, etc.	...	45
From German petroleum	120	150
	930	2005
Heavy Motor Fuels:		
From German petroleum	100	100
Low-temperature coking of lignite	50	130
Low-temperature coking of anthracite	...	15
Normal coking of anthracite	8	10
High-pressure extraction (Stinnes)	...	35
	158	290

According to processes used, the synthetic production of gasoline would be distributed approximately as follows:

	Production, 1935 (in 1,000 metric tons)	Capacity End of 1937 (in 1,000 metric tons)
From Lignite, or Brown Coal:		
Hydrogenation I.G.	230	350
Low-temperature coking (*Schwelung*) Lurgi Hydrogenation of coal tar I.G.	.....	400
Fischer-Tropsch synthesis	.....	150
From Anthracite:		
Hydrogenation I.G.	.....	150
Fischer-Tropsch synthesis	.....	100
Polymerization of gases from synthesis plants:	.....	50
Total production of synthetic gasoline	230	1200

The processes for producing synthetic motor fuels vary, the best known being the I. G. Farben hydrogenation processes and the Fischer-Tropsch benzine synthesis. The I.G. pressure hydrogenation process is accomplished in two stages, first, the so-called "Sumpf" stage in which medium and heavy oils are produced by treating a soft mass of coal and oil, and second, the gas phase in which gasoline is derived from medium oils. The Fischer-Tropsch benzine synthesis involves building up gasoline from a "water gas" which can be produced from anthracite, lignite, coke or gas. The hydrogenation of tar produced through low-temperature coking is continued with high-pressure cracking, similar to petroleum refining. By hydrogenation, one metric ton of water- and ash-free lignite yields about 650 kg. of gasoline or diesel oil. The hydrogenation of one ton of coal tar (won through low-temperature coking) yields 800 to 900 kg. of gasoline.[3]

The I.G. processes account for the largest part of present commercial production, while the plants using the Fischer-Tropsch synthesis are mostly still under construction. The I.G. Leuna hydrogenation plant, built from 1933 to 1935, produced 230,000 metric tons of synthetic gasoline in 1935. Three other hydrogenation plants using I.G. processes are being built. Two of them, Braunkohle-Benzin A.G. (Brabag) plants are being constructed near Leipzig and Magdeburg to produce gasoline from brown coal tar which has been extracted from lignite briquets coked at low temperatures. Each of these plants will have a capacity to process 200,000 tons of coal tar, corresponding to a production of 150-180,000 metric tons of gasoline annually. Another lignite plant in central Germany is the Mitteldeutsche Ol-und Benzin-A.G. established by the Wintershall A.G. in Kassel. It will use the Fischer-Tropsch process, directly from lignite, with a more economical production of the water gas which has so far been the chief cost factor in the Fischer-Tropsch synthesis.

Although the earlier experiments started with lignite, the processing of coal shows certain savings in production, depending upon the type of coal used. Plants producing gasoline on a semi-technical scale from anthracite coal are the Kogasin plant of Ruhr-Chemie A.G., using the Fischer-Tropsch process, and the I.G. plant at Ludwigshafen for the direct hydrogenation of coal, and the I.G. Hydrierwerke Scholven A.G. in the Ruhr, which is now building another coal hydrogenation unit. Recently the Ruhr interests have shown considerable activity in this field. A Studiengesellschaft zur Prüfung der Kohle-Extraktion has been established

[1] According to the latest annual report of the *Reichskohlenverband*.

[2] Figures from Dr. Oetkens' report to the 74th annual meeting of the *Verein deutscher Ingenieure* (VdI).

[3] P. Heinze, *Deutsche Bergwerks-Zeitung*.

in Dortmund to investigate the process of Uhde, mostly for extracting heavier oils. The Stinnes group (Interessengemeinschaft des Mühleimer Bergwerksvereins - Gewerkschaft Mathias Stinnes) has developed a similar, so-called Pott-Broche process. Stinnes is working together with I.G., the former holding the pressure-extraction patents and the latter the hydrogenation patents. The process is said to be very economical and claims to extract 85 per cent of the oil in ash-free coal. Stinnes is building its own plant to have an annual production capacity of 20-50,000 metric tons. Friedrich Krupp A.G. has also constructed new low-temperature coking plants in Essen and in the Saar district, with an annual capacity of 20,000 tons of coke. The Gesellschaft für Brennstofftechnik, Essen, is also interested in producing heavier oils, and is conducting experiments with coal rich in volatile matter treated in narrow low-temperature coking chambers in the Preussag plant in Upper Silesia.

Berg & Co., Cologne, are working with formed low-temperature cokes in gas plants in Nürnberg and other cities. Similar lines are being followed in the application of the Hellmann process. Many municipal gas plants have gone over to regular benzol production as a byproduct. The briqueting and low-temperature coking process developed by Weber for non-coking coal is still in the experimental stage. Other enterprises, such as Hibernia (I.G. process); Klöckner, Rhein-Preussen, and Ewald (Fischer-Tropsch synthesis) have invested considerable sums in their own plants.

The majority of the anthracite producers, however, are still somewhat hesitant in applying the new low-temperature coking processes (Verschwelung). Although the program of the Vereinigung zum Studium der Schwelung (VfS), owned 77.5 per cent by Ruhr mines of the Kohlensyndikat, provides for a production of 100,000 tons of low-temperature coke annually, to date, only two small-scale processes are being tested out in the coking plant of one of the Hoesch mines. Two Berg & Co., Cologne and Hinselmann, Koksofen G.m.b.H., Essen, furnaces are being installed and should be in operation before the end of this year. Using both coking and non-coking coal, they should produce an average of 10 to 20 tons daily. If production proves satisfactory, further units will be built. It is hoped to gain 8 to 10 per cent of the coal as tar and to produce a high quality coke on an economical scale. The Ruhr-Benzin A.G. in Oberhausen, owned 68 per cent by Syndikat members, will soon begin producing benzine and other motor fuels.

It must be remembered that all these processes are still quite expensive and will not immediately affect the oil market unless national necessity dictates otherwise. The future of oil imports will depend in part upon the development of German foreign trade. If it is favorable, the synthetic products will only fill the additional requirements as motorization progresses. If not, the government will probably attempt to reach complete self-sufficiency in motor fuels.

Independence of rubber imports is fast becoming a reality in Germany. The so-called war-time methyl rubber was unsatisfactory and its manufacture was discontinued after the war. When new ways to obtain the basic product for synthetic rubber, butadiene, were found in 1926, experiments were resumed and have led to the present solution of the synthetic rubber problem by I.G. Farben, and the product is now marketed under the trade name of "Buna." The manufacture of butadiene proceeds from lime and coal, to calcium carbide, to acetelyne, to butadiene gas, which is polymerized to caoutschuc. According to the treatment at the last stage the synthetic rubber varies in its technical characteristics. "Buna" is not affected by acids and oils, and tires made of the material have shown excellent wearing qualities in road tests. It is not only a substitute for natural rubber, but in many respects an improvement on it. Several German firms are already engaged in making tires of synthetic rubber. A large scale plant for making "Buna" near Wittenberg is nearing completion and should be operating at full capacity within the next few months.

CALENDAR

TWELFTH NATIONAL EXPOSITION OF POWER AND MECHANICAL ENGINEERING. Grand Central Palace, New York, N. Y., November 30 to December 5.

AMERICAN ASSOCIATION OF TEXTILE CHEMISTS AND COLORISTS, annual meeting, Providence, R. I., December 4-5.

INTERNATIONAL BUREAU FOR TECHNICAL EDUCATION, Rome, Italy, Dec. 28-30.

TECHNICAL ASSOCIATION OF THE PULP & PAPER INDUSTRY, annual meeting, February 22-25, 1937.

AMERICAN CHEMICAL SOCIETY, semi-annual meeting, Chapel Hill, N. C., April 12-15, 1937.

New Thermoplastic Material Offered in Germany

A NEW thermoplastic polyvinyl chloride material for pipes and tubing, "Mipolam" is being introduced by Dynamit A.G. (I.G.), formerly Alfred Nobel & Co. Pipes of the new material are being laid in chemical and rayon plants and in beer breweries to convey acids, alkalies, brine, formalin, alcohol, beer, etc. Its advantages are an unusual resistance to most all acids and lye solutions, mechanical durability, flexibility, light weight, and facility in installation. Mipolam pipes are replacing brittle glass and inflexible earthernware pipes as well as iron and non-corroding steel pipes. One meter of "Mipolam-Rohr" 28 cm. (25 inner) diameter weighs only 175 gr. compared to 1,000 gr. for iron pipe of the same dimensions.

The new pipe can be sawed and bent with the usual saws and tools. The material is non-inflammable but becomes soft at 80° C. so that it can be formed. Two pieces can be easily joined by heating one end until it becomes pliable and then inserting the cold end of the other. In cooling, the warm end shrinks to fit the cold end tightly, and after a thin coat of a solution "PC 20" is applied to the smaller cold end it is reinserted and becomes inseparable.

Zinc Institute Sponsors Galvanizers Committee

DEVELOPMENT in the progress of galvanized sheet production is marked by the initial meeting of the Galvanizers Committee under the sponsorship of the American Zinc Institute at Pittsburgh, Nov. 18 and 19.

The two-day program at Pittsburgh includes morning and afternoon sessions on both days; the subjects for discussion will cover technical and operating problems in the galvanizing department with special reference to the galvanizing of sheets.

Plans will also be presented at this meeting for the formation of a permanent organization including the adoption of a constitution and by-laws. A permanent governing body will be elected to take the place of the temporary Organizing Committee now functioning.

Pending final organization, it has been decided to limit the attendance at the meeting to executive, operating and technical men of companies producing galvanized sheets. Formal invitations are now being issued under the direction of the Organizing Committee and admittance to the meeting will be restricted to those so invited.

Frank C. Whitmore

G. Donald Spackman

L. J. Willien

PERSONALITIES

FRANK C. WHITMORE, dean of the school of chemistry and physics of Pennsylvania State College, has been awarded the William H. Nichols Medal given by the New York section of the American Chemical Society. Dean Whitmore received the award for his outstanding work in aliphatic chemistry and metallo-organic compounds.

HENRY METCALF HOBART, consulting engineer of the General Electric Co., is the recipient of the Samuel Wylie Miller Memorial Medal of the American Welding Society.

SYDNEY B. REDECKER, American consul at Frankfurt-am-Main, has been spending a few weeks in this country. One of his principal assignments is to report on the synthetic organic chemical industry which centers in Frankfurt.

W. J. LAWRENCE, formerly president of Paper Makers Chemical Corp., has been elected a vice-president of Hercules Powder Co. Mr. Lawrence's new office follows the company's recent assimilation of its subsidiary, Paper Makers Chemical Corp.

FRANK G. BREYER, partner in the firm of Singmaster and Breyer, New York, has been elected president of the Association of Consulting Chemists and Chemical Engineers. Thomas A. Wright of Lucius Pitkin, Inc., is retiring officer.

S. B. BRADSHAW has been named manager and Dr. E. E. Pike technical director of Armour Laboratories, Armour & Co., Chicago.

G. DONALD SPACKMAN is the newly-appointed general superintendent of Lukens Steel Co., Coatesville, Pa. Since 1930 Mr. Spackman has served as president of Lukenweld, Inc., a division of Lukens Steel Co. Prior to that time he was fuel engineer for the parent company. Mr. Spackman's appointment follows the resignation of J. H. McElhinney, general superintendent since 1929. Mr. McElhinney has not announced his plans for the future.

P. B. JACOBS, of the U. S. Bureau of Chemistry and Soils, has been transferred to Washington, D. C., where he will take up preliminary investigations of the Bureau on alcohol manufacture. D. F. J. Lynch is leaving the Arlington, Va., laboratories of the Bureau to succeed Mr. Jacobs as chief of the agricultural byproducts laboratories at Ames, Iowa.

D. A. ROBERTS, formerly with the W. E. Mowry Co. of St. Paul, has joined the staff of Battelle Memorial Institute, Columbus, Ohio. Mr. Roberts will work on various phases of research in metallurgy.

J. R. VAN PELT, assistant director in charge of the technical division at the Museum of Science and Industry, Chicago, has been elected president of the Western Society of Engineers for the year 1936-37. The Society, whose headquarters are in Chicago, last year formed a chemical and metallurgical section to meet the demands of a growing number of members in those fields.

L. J. WILLIEN, operating engineer of the Public Utility Service Corp., Chicago, is the American Gas Association medalist this year.

CARL W. BORGMANN, formerly assistant professor of chemical engineering at the University of North Carolina, has accepted a position as assistant to the director of research at the National Tube Co., Pittsburgh, Pa.

J. F. STONE has been made manager of the insulation department of the Johns-Manville Co.

H. D. WHITTLESEY, A. W. STEUDEL and K. H. WOOD of the Sherwin-Williams Co. have been promoted recently. Mr. Whittlesey has been relieved of the duties of sales direction and distribution and will devote his entire time to executive duties as first vice-president of the company. Mr. Steudel has been made vice-president and general manager of the company. Mr. Wood will assume the duties of direction and distribution of sales.

WILLIS F. AVERY, for the past twelve years in charge of chemical and compounding cases in the legal department of the B. F. Goodrich Co., has been elected assistant secretary of the company.

HENRY L. COLES has resigned his position as head of the department of chemical engineering at the University of Detroit to assume similar duties at the University of Colorado.

Harry L. Fisher

HARRY L. FISHER has joined the research staff of the U. S. Industrial Alcohol Co. at Stamford, Conn. For the past seventeen years. Dr. Fisher has been identified with the rubber industry, having served the B. F. Goodrich Co. and U. S. Rubber Co. successively. He is well known for his research in the fields of rubber, resins, organic combustion and heterocyclic nitrogen compounds.

WILLIAM P. YANT, well known to American industry as the chief chemist in the Health Division of the U. S. Bureau of Mines, has accepted the position of director of research for Mine Safety Appliances Co. of Pittsburgh, Pa.

ROBERT SCHMEIDLER has joined the staff of Kenney-Herstein, Inc., Consulting Chemists, New York City, as consultant in production and application of chemical materials in the textile field. For the past eleven years Mr. Schmeidler has been connected with the United Piece Dye Works as chemist.

J. WILLIAM GRANT has been placed in charge of the engineering department of The Atlas Mineral Products Co., Mertztown, Pa. Mr. Grant is a graduate of Carnegie Institute of Technology.

HAROLD K. WORK is the new director of the Research and Development Dept. of Jones & Laughlin Steel Co., Pittsburgh. Dr. Work was formerly chemical engineer for the Aluminum Co. of America and head of the Electro-Chemical Division of the Aluminum Research Laboratories.

E. E. SLOWTER, formerly with the Pittsburgh Plate Glass Co., has accepted a position on the staff of Battelle Memorial Institute, Columbus, Ohio.

WARD H. SACKS has been added to the staff of E. I. du Pont de Nemours & Co., Ammonia Division. A well-known agronomist. Mr. Sacks has formerly been affiliated with the National Fertilizer Association and the American Cyanamid Co.

CHARLES G. DUNCOMBE has resigned as assistant professor of chemical engineering at Ohio State University to become professor and head of the chemical engineering department at the University of Detroit.

E. W. COMINGS, D. Sc. '34, M.I.T., has joined the faculty of the Univ. of Illinois as assistant professor of chemical engineering. Dr. Comings is filling the vacancy left by the resignation of Dr. Norman W. Krase, who now heads the department of chemical engineering at the Univ. of Pennsylvania.

H. L. MINER, E. I. duPont de Nemours & Co., has been elected general chairman of the chemical section executive committee of the National Safety Council. Other elections were Ralph L. Rogers, Jr., Tennessee Eastman Corp., vice-chairman in charge of program; J. J. B. Fulenwider, Hercules Powder Co., vice-chairman in charge of engineering; and Ralph O. Keefer, Aluminum Co. of America, secretary.

O. A. HOUGEN, associate professor of chemical engineering at the University of Wisconsin, and recently on leave as director of the laboratories of U. S. Testing Co. in Hoboken, N. J., plans to join the department of chemical engineering at Armour Institute of Technology in February.

Alfred McLaren White

OBITUARY

ALFRED MCLAREN WHITE, head of the chemical engineering department at the University of Virginia, died of nephritis on Sept. 23. A biographical sketch of Dr. White appeared on the news pages of last month's issue of *Chem. & Met.*

CHARLES I. FIERO, retired vice-president of the Standard Oil Co. of Louisiana, died Oct. 14 at Bronxville, N. Y. Mr. Fiero was 73 years old and had spent practically all of his business life with the Standard Oil Co.

ALLEN CURTIS, vice-president in charge of manufacturing of the International Paper Co., died at his estate at Sand Lake, N. Y. on Sept. 9. He was 59 years old.

GEORGE F. HASSLACHER was killed Sept. 16 when he fell sixteen stories from the window of his office in New York City. He was a member of the firm of Snyder MacLaren Processes, Inc., New York, and was a former director and assistant secretary of the Roessler-Hasslacher Chemical Co. which was founded by his father, the late Jacob Hasslacher. Mr. Hasslacher was a member of the American Chemical Society.

GEORGE DRASIN was killed Oct. 16 by a gas explosion in the chemical engineering laboratory of the University of Michigan. Mr. Drasin was a graduate student in chemical engineering and was an assistant in the department of engineering research at the University.

F. C. GOLDSBOROUGH, eastern sales manager for U. S. Industrial Alcohol Co., died Sept. 22 at his home in Plainfield, N. J. His death occurred after a prolonged illness induced by pneumonia. Prior to his connection with U.S.I., Mr. Goldsborough was sales manager for the American Solvent and Chemical Corp. until it was acquired by the Commercial Solvents Corp. in 1933.

JAMES T. SKELLY, vice-president and director of Hercules Powder Co. died at Wilmington, Del., on Oct. 31, following an illness of six weeks. Mr. Skelly was very well known in the explosives-consuming industries. He served with Laflin and Rand Powder Co. and with the du Pont Sporting Powder Division before coming to Hercules in 1913.

THOMAS MARTIN LOWRY, president of the Faraday Society, London, died Nov. 3 at the age of 62. He has been professor of physical chemistry at Cambridge University since 1920.

Chemical ECONOMICS

INDUSTRIAL production in September as measured by the index of the Federal Reserve System reached a new high for a more than six year period. The index as adjusted for seasonal variations was 109 with 1923-1925 representing 100. Production in October can not yet be given in mathematical terms but is reported to have gone along at a rate higher than was reported for September.

Marked gains in total net sales and a higher rate of collections on accounts receivable in September as compared with September a year ago were reported by manufacturers in the monthly joint study of the National Association of Credit Men and the Bureau of Foreign and Domestic Commerce.

Total net sales of 585 manufacturers throughout the country registered an increase of over 25 per cent in September, 1936 from September, 1935. Without adjustment for seasonal influences, September, 1936 sales registered an increase of over 3 per cent from August of this year.

Total sales increased in September, 1936 over the same month last year for all of 15 industry groups shown in the report. The increases ranged from 12 per cent for textiles and their products to over 46 per cent for iron and steel and their products. Increases in September, 1936 sales over September, 1935 for stone, clay and glass products, machinery, and non-ferrous metals also were high, each exceeding 35 per cent.

For chemicals and allied products a gain of 15.7 per cent is reported; for paints and varnishes, a gain of 15.5 per cent; for petroleum products, a gain of 20.4 per cent; for paper and allied products, a gain of 18.2 per cent; for rubber products, a gain of 22.8 per cent; for leather and its products, a gain of 13.8 per cent; all these comparisons being for September, 1936 and September, 1935.

There were 27 mills in the United States which crushed flaxseed during the quarter ended September 30, reporting a crush of 134,884 tons of flaxseed and a production of 91,098,335 lb. of linseed oil, the Department of Commerce reported.

These figures compare with 167,952 tons of seed crushed and 116,666,553 lb. of oil produced in the corresponding quarter of 1935.

The third quarter soy bean crush produced 44,199,118 lb. of oil, according to reports from 30 mills compared with a production of 19,083,017 lb. of oil by 21 mills in the same quarter of 1935.

Consumption of crude rubber by manufacturers in the United States in September was 24.9 per cent above the same month of last year. September consumption amounted to 46,330 tons, as against 46,657 tons in August, and 37,086 tons in September, 1935, according to the Rubber Manufacturers Association.

Consumption for the first nine months of the year now amounts to 424,084 tons, as against 364,791 tons for the same period of last year. That is an increase of 16 per cent over last year. Consumption for the whole year 1935 reached 491,544 tons, which was the highest annual total reported until last year, including the boom years 1928 and 1929. This year a new all-time high will be set.

The upward trend in fertilizer tax tag sales which had been evident in recent months continued in September on the basis of reports by state officials. Totaling 257,775 tons in the 17 reporting states, September tax tag sales were the largest on record for the month, exceeding September, 1935 by 51 per cent. Sales in the first three months of the current fiscal year, from July through September, amounted to 470,000 tons as against 299,000 tons in the corresponding period of last year; in the July-September quarter of 1932, at the bottom of the depression, sales were only 190,000 tons.

The rise in superphosphate production which had been evident for several months continued in September, according to reports by acidulators to The National Fertilizer Association. Production last month exceeded September 1935 by 36 per cent, with both areas reporting substantial increases. For the first nine months of this year production in the plants regularly surveyed by the Association was 12 per cent larger than in the same month of 1935.

Every class of shipments in September showed an increase over September of last year. Shipments to consumers by the reporting establishments last month of 101,500 tons were the largest for the month in at least six years and were 62 per cent larger than last year.

Foreign trade in chemicals and related products as included in Group 8 of the Monthly Summary of Foreign Commerce is represented for August by a valuation of $9,190,918 for exports and $5,335,626 for imports. Chemical specialties accounted for $1,800,000 of the export total with large shipments of copper sulphate, agricultural insecticides, water softeners, etc. In the industrial chemical section, boric acid was prominent because exports in August were 679,183 lb. In the solvents list exports included 505,814 lb. of acetone and 420,913 lb. of butyl acetate.

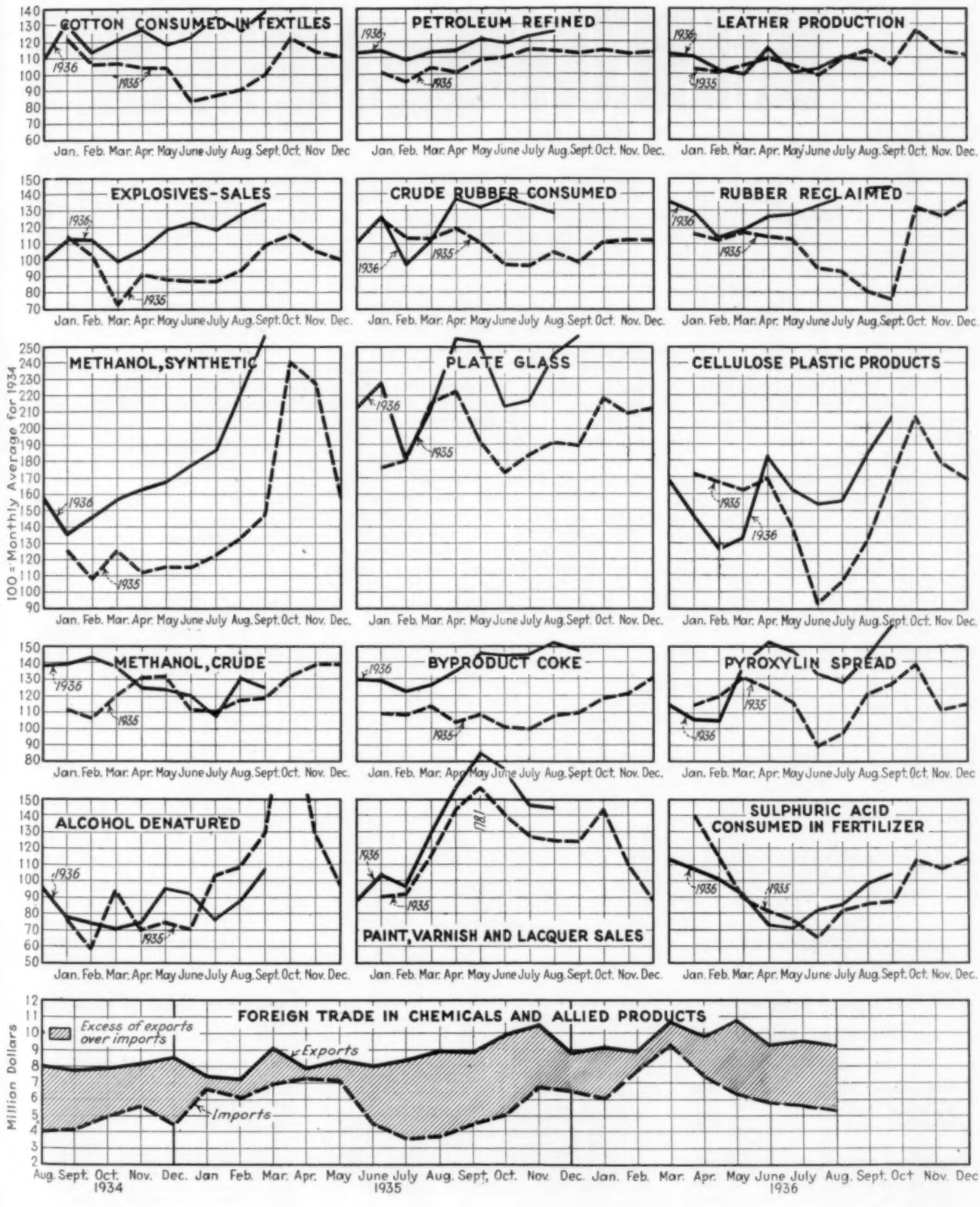
Outward shipments of sodium compounds amounted to 47,323,684 lb. Borax was the leader with 19,390,498 lb. followed by caustic soda with 12,924,276 lb., soda ash with 9,359,778 lb., and bicarbonate with 1,525,495 lb. Exports of silicate of soda for the month were 1,368,228 lb. which shows the extent to which foreign trade in this product has declined from the time that Canadian production was enlarged.

Production and Consumption Data for Chemical Consuming Industries

	Sept. 1936	Sept. 1935	Jan.-Sept. 1936	Jan.-Sept. 1935	Gain Jan.-Sept. 1936 over Jan.-Sept. 1935 Per cent
Production					
Alcohol denatured, 1000 wi. gal	8,604	10,211	60,205	62,098	3.1*
Automobiles, No.	135,130	87,540	3,336,296	2,875,304	16.0
Ammonia, tons	61,256	44,738	510,131	381,873	33.6
Benzol, 1000 gal	9,089	6,799	76,991	55,996	35.7
Byproduct coke, 1000 tons	3,831	2,836	32,037	24,737	29.6
Cellulose acetate plastics, 1000 lb.	1,204	882	8,882	6,906	12.9
Nitrocellulose plastics, 1000 lb	1,787	1,551	12,137	11,778	3.0
Glass containers, 1000 gr	3,994	3,102	33,053	28,809	14.7
Plate glass, 1000 sq. ft.	19,553	14,404	156,771	131,202	19.5
Methanol, crude, gal	429,500	405,034	3,983,152	3,637,682	9.5
Methanol, synthetic, gal	2,695,591	1,539,554	16,857,983	11,509,682	46.5
Rosin, wood, bbl	57,789	47,388	487,954	415,335	17.5
Turpentine, wood, bbl	8,578	7,550	77,639	63,051	23.1
Steel barrels, No	791,079	623,797	5,974,581	4,822,604	23.8
Consumption					
Cotton, 1000 bales	630	449	5,128	4,083	25.6
Silk, bales	45,709	45,156	329,519	376,405	12.5*
Explosives, sales, 1000 lb	34,151	27,940	269,381	215,850	24.8
Paint, varnish, and lacquers, sales, $1,000	33,450	28,536	290,540	255,959	13.5

* Per cent of decline.

TRENDS OF PRODUCTION AND CONSUMPTION



The MARKETS

INTEREST in contracts for 1937 delivery has been apparent in the last month and considerable business has been placed in forward positions. The contracting season, however, has been much more restricted than usual. For many chemicals, producers have been reluctant to quote for distant deliveries. While prices for the majority of chemicals are not subject to sharp fluctuations in a normal year, there are factors at present which make future production costs more or less uncertain and the volume of contract business so far written has been limited accordingly.

Price changes in the last month have been rather numerous in both directions. Metal salts have followed the rise in the basic materials with such products as red lead, litharge, orange mineral, tin oxide and tin crystals selling at higher levels. Glycerine, which has been in limited supply for a long time, is quotably higher but the open quotations for months have been purely nominal. Lower prices are in effect for prussiate of soda, titanium oxide and lithopone.

The Omnibus Tax Bill as drawn by the Senate of Texas was approved by the House on Oct. 27. The new bill increases the tax on oil production in that state from 2c to 2¼c; carbon black from 2 per cent to 3 per cent; and sulphur from 75c a ton to $1.03 a ton. As Louisiana recently increased the production tax on sulphur to $2 a ton, it is expected that mining of sulphur will be largely centralized in Texas where taxation, although higher than before, is still more favorable.

Sales of different products which enter the anti-freeze trade have been made in large volume in recent weeks. While weather conditions are important in determining the actual consumption of these products, reports are heard to the effect that sales schedules of some producers have been set at higher quotas than was the case a year ago. Apparently competition for larger parts of anti-freeze business will be keen not only between individual producers but also between individual products. Denatured alcohol of anti-freeze grade was reduced 4c a gal. in the latter part of October.

In connection with the decline of 1c a lb. in the contract price for prussiate of soda it is noted that a Japanese company is reported to have increased its monthly output from 40 tons to 60 tons. The reason for the enlarged production was given as due to larger buying on the part of the United States. The Department of Commerce credits Japan with shipping 45 per cent of our prussiate imports of 663,393 lb. last year. Imports for the first eight months this year amounted to 1,116,885 lb., but the monthly reports do not show the countries of origin.

The Bureau of the Census reports factory production of fats and oils for the three month period ended Sept. 30 as follows: Vegetable oils, 484,565,176 lb.; fish oils, 82,200,822 lb.; animal fats, 375,492,864 lb.; grease, 82,138,725 lb.—a grand total of 1,024,397,587 lb. It is interesting to note that of the total given above for production of vegetable oils, babassu oil accounted for 6,049,466 lb. Hence domestic production of that oil is becoming important. Most of this oil enters the edible trades.

According to the Commerce Department's Chemical Division United States iodine output in 1935 based on sales by producers amounted to 245,700 lb. and has averaged 276,500 lb. per annum during the past four years—the output in 1933 running as high as 401,500 lb.

Imports of crude iodine, chiefly from Chile where it is produced as a by-product of the nitrate industry, amounted to 376,000 lb. in 1935, compared with 1,479,000 lb. during the preceding year, and an annual average of 836,000 lb. during the past five years. Further marked declines have occurred during the current year, receipts during the first seven months amounting to only 50,000 lb.

Promising results that have followed experimental growing of tung trees and perilla plants has prompted the Department of Agriculture to make a world-wide survey of other oil-producing plants to determine the possibility of growing them in this country. Perilla plants now are being grown in thirty-three states. Demand for oils that impart particular qualities to paints and varnishes is resulting in a world-wide scrutiny for numerous agencies of oil-producing plants to determine their properties and possible uses.

New activated carbon paints recently placed on the market in Germany give promise of being satisfactory for metal protection coatings and are expected to reduce consumption of pigments containing lead, practically all of which must be imported, a report from Frankfort-on-Main states. Extensive tests carried out by the Reich Railways are said to have shown good results for nearly all purposes.

A new German filtering material known as "magnodoppelsatz" made entirely of domestic materials is now being distributed in that country. The material is a dolomite rock quarried in Westphalia. Its principal use is in deacidifying drinking water by simple filtration.

An Italian company is conducting experiments with ammonia gas as a motor fuel and is said to be equipping a large motor car for demonstration purposes, according to reports from Rome.

French domestic orders for potash increased 35 per cent during the four summer months ending August 31 compared with the same period of 1935 and sales for export advanced 30 per cent, a report from Paris states.

CHEM. & MET. Weighted Index of CHEMICAL PRICES

Base = 100 for 1927

This month	**86.70**
Last month	86.76
November, 1935	87.20
November, 1934	87.91

Lower prices were announced for anti-freeze grade of alcohol, prussiate of soda, titanium oxide, and lithopone. Higher prices were in effect for lead oxides, tin salts, and naval stores products. Net effect was a slight drop in the weighted index number.

CHEM. & MET. Weighted Index of Prices for OILS AND FATS

Base = 100 for 1927

This month	**91.36**
Last month	92.56
November, 1935	92.20
November, 1934	74.55

Crude cottonseed, linseed, and China wood were lower during the period. A strong market for copra strengthened coconut oil but part of earlier price advances were lost at the close. Tallow and glycerine brought higher prices.

Current PRICES

The following prices refer to round lots in the New York market. Where it is the trade custom to sell f.o.b. works, quotations are given on that basis and are so designated. Prices are corrected to November 10.

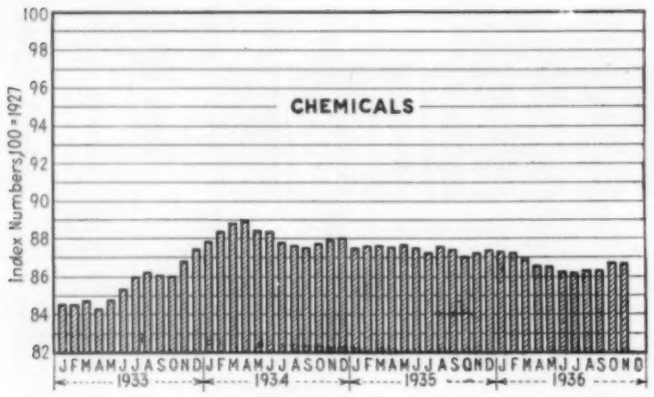
Industrial Chemicals

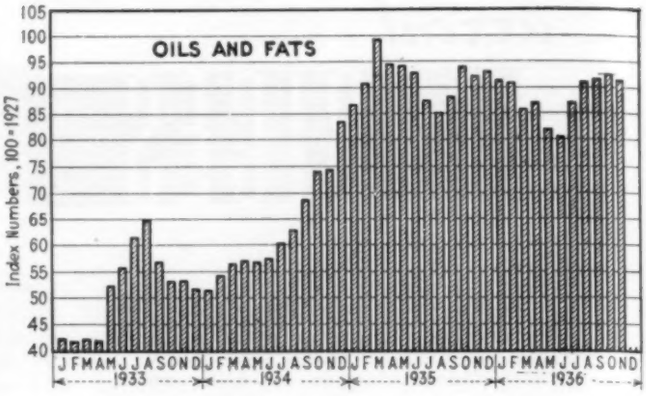
	Current Price	Last Month	Last Year
Acetone, drums, lb.	$0.08 –$0.09	$0.08 –$0.09	$0.12–$0.12½
Acid, acetic, 28%, bbl., cwt.	2.45 – 2.70	2.45 – 2.70	2.45 – 2.70
Glacial 99%, drums	8.43 – 8.68	8.43 – 8.68	8.43 – 8.68
U. S. P. reagent	10.52 –10.77	10.52 –10.77	10.52 –10.77
Boric, bbl., ton	105.00–115.00	105.00–115.00	105.00–115.00
Citric, kegs, lb.	.25 – .28	.25 – .28	.28 – .31
Formic, bbl., ton	.11 – .11½	.11 – .11½	.11 – .11½
Gallic, tech., bbl., lb.	.60 – .65	.60 – .65	.60 – .65
Hydrofluoric 30% carb., lb.	.07 – .07½	.07 – .07½	.07 – .07½
Lactic, 44%, tech., light, bbl., lb.	.11½– .12	.11½– .12	.12 – .12½
Muriatic, 18°, tanks, cwt.	1.00 – 1.10	1.00 – 1.10	1.00 – 1.10
Nitric, 36°, carboys, lb.	.05 – .05½	.05 – .05½	.05 – .05½
Oleum, tanks, wks., ton	18.50 –20.00	18.50 –.....	18.50 –20.00
Oxalic, crystals, bbl., lb.	.11½– .12½	.11½– .12½	.11½– .12½
Phosphoric, tech., c'bys., lb.	.09 – .10	.09 – .10	.09 – .10
Sulphuric, 60°, tanks, ton	11.00 –11.50	11.00 –11.50	11.00 –11.50
Sulphuric, 66°, tanks, ton	15.50 –.....	15.50 –.....	15.50 –.....
Tannic, tech., bbl., lb.	.20 – .30	.20 – .30	.23 – .35
Tartaric, powd., bbl., lb.	.24 – .25	.24 – .25	.24 – .25
Tungstic, bbl., lb.	1.50 – 1.60	1.50 – 1.60	1.50 – 1.60
Alcohol, Amyl, ...	.....	.....	.....
From Pentane, tanks, lb.	14.3 –.....	14.3 –.....	.15 –.....
Alcohol, Butyl, tanks, lb.	.08½–.....	.08½–.....	.12 –.....
Alcohol, Ethyl, 190 p'f., bbl., gal.	4.14 –.....	4.14 –.....	4.27½–.....
Denatured, 190 proof			
No. 1 special, dr., gal wks.	.32 –.....	.32 –.....	.28 –.....
Alum, ammonia, lump, bbl., lb.	.03 – .04	.03 – .04	.03 – .04
Chrome, bbl., lb.	.04½– .05	.04½– .05	.04½– .05
Potash, lump, bbl., lb.	.03 – .04	.03 – .04	.03 – .04
Aluminum sulphate, com., bags cwt.	1.35 – 1.50	1.35 – 1.50	1.35 – 1.50
Iron free, bg., cwt.	2.00 – 2.25	2.00 – 2.25	1.90 – 2.00
Aqua ammonia, 26°, drums, lb.	.02½– .03	.02½– .03	.02½– .03
tanks, lb.	.02½– .02¾	.02½– .02¾	.02½– .02¾
Ammonia, anhydrous, cyl., lb.	.15½– .16	.15½– .16	.15½– .16
tanks, lb.	.04½–.....	.04½–.....	.04½–.....
Ammonium carbonate, powd. tech., casks, lb.	.08 – .12	.08 – .12	.08 – .12
Sulphate, wks., cwt.	1.25 –.....	1.25 –.....	1.20 –.....
Amylacetate tech., tanks, lb.	.12 – .135	.12 – .135	.142–.....
Antimony Oxide, bbl., lb.	.12½– .13½	.12½– .13½	.14 – .14½
Arsenic, white, powd., bbl., lb.	.03½– .04	.03½– .04	.03½– .04
Red, powd., kegs, lb.	.15½– .16	.15½– .16	.15½– .16
Barium carbonate, bbl., ton	56.50 –58.00	56.50 –58.00	56.50 –58.00
Chloride, bbl., ton	72.00 –74.00	72.00 –74.00	72.00 –74.00
Nitrate, cask, lb.	.08½– .09	.08½– .09	.08½– .09
Blanc fixe, dry, bbl., lb.	.03½– .04	.03½– .04	.03½– .04
Bleaching powder, f.o.b., wks., drums, cwt.	2.00 – 2.10	2.00 – 2.10	1.90 – 2.00
Borax, gran., bags, ton	44.00 –49.00	44.00 –49.00	44.00 –49.00
Bromine, cs., lb.	.36 – .38	.36 – .38	.36 – .38
Calcium acetate, bags	2.10 –.....	2.10 –.....	2.10 –.....
Arsenate, dr., lb.	.06 – .07	.06 – .07	.06 – .07
Carbide drums, lb.	.05 – .06	.05 – .06	.05 – .06
Chloride, fused, dr., del., ton	20.00 –33.00	20.00 –33.00	20.00 –33.00
flake, dr., del., ton	22.00 –35.00	22.00 –35.00	22.00 –35.00
Phosphate, bbl., lb.	.07½– .08	.07½– .08	.07½– .08
Carbon bisulphide, drums, lb.	.05½– .06	.05½– .06	.05½– .06
Tetrachloride drums, lb.	.05½– .08½	.05½– .06	.05½– .06
Chlorine, liquid, tanks, wks., lb.	2.15 –.....	2.15 –.....	2.00 –.....
Cylinders	.05½– .06	.05½– .06	.05½– .06
Cobalt oxide, cans, lb.	1.41 – 1.51	1.41 – 1.51	1.39 – 1.45
Copperas, bgs., f.o.b., wks., ton	15.00 –16.00	15.00 –16.00	14.00 –15.00
Copper carbonate, bbl., lb.	.08½– .16	.08½– .16	.08½– .16
Sulphate, bbl., cwt.	4.15 – 4.40	4.00 – 4.25	3.85 – 4.00
Cream of tartar, bbl., lb.	.16½– .17	.16½– .17	.16½– .17
Diethylene glycol, dr., lb.	.16½– .20½	.16½– .20½	.16½– .20½
Epsom salt, dom., tech., bbl., cwt.	1.80 – 2.00	1.80 – 2.00	2.10 – 2.15
Ethyl acetate, drums, lb.	.07 –.....	.07 –.....	.08½–.....
Formaldehyde, 40%, bbl., lb.	.06 – .07	.06 – .07	.06 – .07
Furfural, dr., lb.	.10 – .17½	.10 – .17½	.10 – .17½
Fusel oil, ref. drums, lb.	.16 – .18	.16 – .18	.16 – .18
Glaubers salt, bags, cwt.	.85 – 1.00	.85 – 1.00	1.00 – 1.10
Glycerine, c.p., drums, extra, lb.	.19½–.....	.19½–.....	.14 – .14½
Lead:			
White, basic carbonate, dry casks, lb.	.06½–.....	.06½–.....	.06½–.....
White, basic sulphate, sck., lb.	.06 –.....	.06 –.....	.06 –.....
Red, dry, sck., lb.	.07½–.....	.07 –.....	.06½–.....
Lead acetate, white crys., bbl., lb.	.11 – .11½	.10½– .11	.10½– .11
Lead arsenate, powd., bbl., lb.	.09 – .10	.09 – .10	.09 – .10
Lime, chem., bulk, ton	8.50 –.....	8.50 –.....	8.50 –.....
Litharge, pwd., csk., lb.	.06½–.....	.06 –.....	.05½–.....
Lithophone, bags, lb.	.04½– .05	.04½– .05	.04½– .05
Magnesium carb., tech., bags, lb.	.06½– .06½	.06 – .06½	.06 – .06½
Methanol, 95%, tanks, gal.	.33 –.....	.33 –.....	.33 –.....
97%, tanks, gal.	.34 –.....	.34 –.....	.34 –.....
Synthetic, tanks, gal.	.35½–.....	.35½–.....	.35½–.....
Nickel salt, double, bbl., lb.	.13 – .13½	.13 – .13½	.12½– .13
Orange mineral, csk., lb.	.10½–.....	.10 –.....	.10 –.....
Phosphorus, red, cases, lb.	.44 – .45	.44 – .45	.44 – .45
Yellow, cases, lb.	.28 – .32	.28 – .32	.28 – .32
Potassium bichromate, casks, lb.	.08½– .09	.08½– .09	.07½– .08½
Carbonate, 80–85%, calc. csk., lb.	.07 – .07½	.07 – .07½	.07 – .07½
Chlorate, powd., lb.	.08 – .08½	.08 – .08½	.08½– .09
Hydroxide (c'stic potash) dr., lb.	.06½– .06½	.06½– .06½	.06½– .06½
Muriate, 80% bgs., ton	23.00 –.....	23.00 –.....	22.00 –.....
Nitrate, bbl., lb.	.05½– .06	.05½– .06	.05½– .06
Permanganate, drums, lb.	.18½– .19	.18½– .19	.18½– .19
Prussiate, yellow, casks, lb.	.18 – .19	.18 – .19	.18 – .19
Sal ammoniac, white, casks, lb.	.04½– .05	.04½– .05	.04½– .05
Salsoda, bbl., cwt.	1.00 – 1.05	1.00 – 1.05	1.00 – 1.05
Salt cake, bulk, ton	13.00 –15.00	13.00 –15.00	13.00 –15.00
Soda ash, light, 58%, bags, contract, cwt.	1.23 –.....	1.23 –.....	1.23 –.....
Dense, bags, cwt.	1.25 –.....	1.25 –.....	1.25 –.....
Soda, caustic, 76%, solid, drums, contract, cwt.	2.60 – 3.00	2.60 – 3.00	2.60 – 3.00
Acetate, works, bbl., lb.	.04½– .05	.04½– .05	.04½– .05
Bicarbonate, bbl., cwt.	1.85 – 2.00	1.85 – 2.00	1.85 – 2.00
Bichromate, casks, lb.	.06½– .07	.06½– .07	.05½– .06½
Bisulphate, bulk, ton	15.00 –16.00	15.00 –16.00	15.00 –16.00
Bisulphite, bbl., lb.	.03½– .04	.03½– .04	.03 – .04
Chlorate, kegs, lb.	.06½– .06½	.06½– .06½	.06½– .06½
Chloride, tech., ton	12.00 –14.75	12.00 –14.75	12.00 –14.75
Cyanide, cases, dom., lb.	.15½– .16	.15½– .16	.15½– .16
Fluoride, bbl., lb.	.07½– .08	.07½– .08	.07½– .08
Hyposulphite, bbl., cwt.	2.40 – 2.50	2.40 – 2.50	2.40 – 2.50
Metasilicate, bbl., cwt.	2.15 – 3.15	2.75 – 3.00	3.25 – 3.40
Nitrate, bags, cwt.	1.375–.....	1.29 –.....	1.275–.....
Nitrite, casks, lb.	.07½– .08	.07½– .08	.07½– .08
Phosphate, dibasic, bbl., lb.	.022– .023	.022– .023	.022– .024
Prussiate, yel. drums, lb.	.10 – .11	.11½– .12	.11½– .12
Silicate (40° dr.) wks., cwt.	.80 – .85	.80 – .85	.80 – .85
Sulphide, fused, 60–62%, dr., lb.	.02½– .03½	.02½– .03	.02½– .03
Sulphite, cyrs., bbl., lb.	.02½– .02½	.02½– .02½	.02½– .02½
Sulphur, crude at mine, bulk, ton.	18.00 –.....	18.00 –.....	18.00 –.....
Chloride, dr., lb.	.03½– .04	.03½– .04	.03½– .04
Dioxide, cyl., lb.	.06½– .08	.06½– .08	.07 – .07½
Flour, bag, cwt.	1.60 – 3.00	1.60 – 3.00	1.60 – 3.00
Tin Oxide, bbl., lb.	.52 –.....	.49 –.....	.54 –.....
Crystals, bbl., lb.	.38½–.....	.35 –.....	.38½–.....
Zinc, chloride, gran., bbl., lb.	.05 – .06	.05 – .06	.05 – .06
Carbonate, bbl., lb.	.09 – .11	.09 – .11	.09 – .11
Cyanide, dr., lb.	.36 – .38	.36 – .38	.36 – .38
Dust, bbl., lb.	.068– .07	.068– .07	.066– .07
Zinc oxide, lead free, bag., lb.	.05½–.....	.05½–.....	.05 –.....
5% lead sulphate, bags, lb.	.05½–.....	.05½–.....	.04½–.....
Sulphate, bbl., cwt.	2.65 – 3.00	2.65 – 3.00	2.75 – 3.00

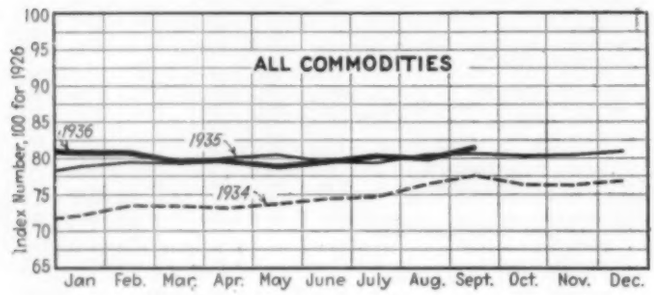
Oils and Fats

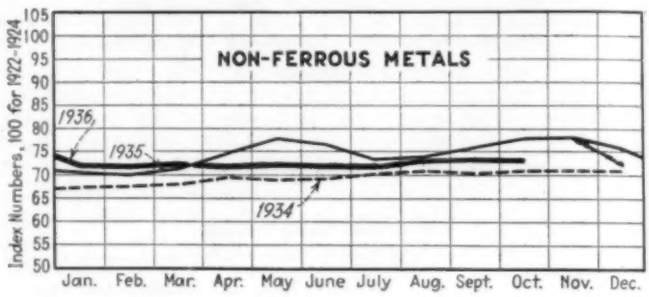
	Current Price	Last Month	Last Year
Castor oil, No. 3, bbl., lb.	$0.10 –$0.11	$0.10 –$0.11	$0.10 –$0.11
Chinawood oil, bbl., lb.	.13½–.....	.14½–.....	.19 –.....
Coconut oil, Ceylon, tanks, N. Y. lb.	.06½–.....	.05½–.....	.04½–.....
Corn oil crude, tanks, (f.o.b. mill), lb.	.08½–.....	.09½–.....	.09½–.....
Cottonseed oil, crude (f.o.b. mill), tanks, lb.	.08½–.....	.08½–.....	.08½–.....
Linseed oil, raw car lots, bbl., lb.	.094–.....	.097–.....	.097–.....
Palm, casks, lb.	.05 –.....	.05 –.....	.04½–.....
Palm kernel, bbl., lb.	.05½–.....	.05½–.....	.05½–.....
Peanut oil, crude, tanks (mill), lb.	.08½–.....	.08½–.....	.09½–.....
Rapeseed oil, refined, bbl., gal.	.73 –.....	.70 –.....	.52 –.....
Soya bean, tank, lb.	.08½–.....	.08 –.....	.09 –.....
Sulphur (olive foots), bbl., lb.	.09½–.....	.09½–.....	.09½–.....
Cod, Newfoundland, bbl. gal.	.48 –.....	.43 –.....	.35 –.....
Menhaden, light pressed, bbl., lb.	.07 –.....	.068–.....	.072–.....
Crude, tanks (f.o.b. factory), gal.	.30 –.....	.30 –.....	.32 –.....
Grease, yellow, loose, lb.	.06½–.....	.06½–.....	.06½–.....
Oleo stearine, lb.	.10 –.....	.10 –.....	.11½–.....
Red oil, distilled, d.p. bbl., lb.	.09½–.....	.09½–.....	.09½–.....
Tallow, extra, loose, lb.	.06½–.....	.06½–.....	.07½–.....

CHEM. & MET.'S WEIGHTED PRICE INDEXES









Coal-Tar Products

	Current Price	Last Month	Last Year
Alpha-napthol, crude, bbl., lb.	$0.60 –$0.65	$0.60 –$0.65	$0.60 –$0.62
Refined, bbl., lb.	.80 – .85	.80 – .85	.80 – .85
Alpha-napthylamine, bbl., lb.	.32 – .34	.32 – .34	.32 – .34
Aniline oil, drums, extra, lb.	.14½– .15	.14½– .15	.14½– .15
Aniline salts, bbl., lb.	.24 – .25	.24 – .25	.24 – .52
Benzaldehyde, U.S.P., dr., lb.	1.10 – 1.25	1.10 – 1.25	1.10 – 1.25
Benzidine base, bbl., lb.	.65 – .67	.65 – .67	.65 – .67
Benzoic acid, U.S.P., kgs., lb.	.48 – .52	.48 – .52	.48 – .52
Benzyl chloride, tech., dr., lb.	.30 – .35	.30 – .35	.30 – .35
Benzol, 90%, tanks, works, gal.	.16 – .18	.16 – .18	.15 – .16
Beta-napthol, tech., drums, lb.	.24 – .27	.24 – .27	.22 – .24
Cresol, U.S.P., dr., lb.	.10 – .11	.10 – .11	.11 – .11½
Cresylic acid, 99%, dr., wks., gal.	.73 – .75	.73 – .75	.45 – .46
Diethylaniline, dr., lb.	.55 – .58	.55 – .58	.55 – .58
Dinitrophenol, bbl., lb.	.29 – .30	.29 – .30	.29 – .30
Dinitrotoluen, bbl., lb.	.16 – .17	.16 – .17	.16 – .17
Dip oil, 25%, dr., gal.	.23 – .25	.23 – .25	.23 – .25
Diphenylamine, bbl., lb.	.38 – .40	.38 – .40	.38 – .40
H-acid, bbl., lb.	.65 – .70	.65 – .70	.65 – .70
Napthalene, flake, bbl., lb.	.07½– .07½	.07½– .07½	.05½– .06
Nitrobensene, dr., lb.	.08½– .09	.08½– .09	.08½– .10
Para-nitraniline, bbl., lb.	.51 – .55	.51 – .55	.51 – .55
Phenol, U.S.P., drums, lb.	.14½– .15	.14½– .15	.14½– .15
Picric acid, bbl., lb.	.30 – .40	.30 – .40	.30 – .40
Pyridine, dr., gal.	1.10 – 1.15	1.10 – 1.15	1.10 – 1.15
Resorcinal, tech., kegs, lb.	.65 – .70	.65 – .70	.65 – .70
Salicylic acid, tech., bbl., lb.	.40 – .42	.40 – .42	.40 – .42
Solvent naptha, w.w., tanks, gal.	.26 –.....	.26 –.....	.26 –.....
Tolidine, bbl., lb.	.88 – .90	.88 – .90	.88 – .90
Toluene, tanks, works, gal.	.30 –.....	.30 –.....	.30 –.....
Xylene, com., tanks, gal.	.30 –.....	.30 –.....	.30 –.....

Miscellaneous

	Current Price	Last Mont	Last Year
Barytes, grid., white, bbl., ton.	$22.00–$25.00	$22.00–$25.00	$22.00–$25.00
Casein, tech., bbl., lb.	.17 – .18	.17 – .18	.14 – .15
China clay, dom., f.o.b. mine, ton.	8.00 –20.00	8.00 –20.00	8.00 –20.00
Dry colors:			
Carbon gas, black (wks.), lb.	.04 – .20	.04 – .20	.04 – .20
Prussian blue, bbl., lb.	.37 – .38	.37 – .38	.36½– .37
Ultramarine blue, bbl., lb.	.10 – .26	.10 – .26	.06 – .32
Chrome green, bbl., lb.	.26 – .27	.26 – .27	.26 – .27
Carmine red, tins, lb.	4.00 – 4.40	4.00 – 4.40	4.00 – 4.40
Para toner, lb.	.75 – .80	.80 – .85	.80 – .85
Vermilion, English, bbl., lb.	1.69 – 1.72	1.75 – 1.78	1.58 – 1.60
Chrome yellow, C. P., bbl., lb.	.13 – .14	.13 – .14	.15 – .15½
Feldspar, No. 1 (f.o.b. N.C.), ton.	6.50 – 7.50	6.50 – 7.50	6.50 – 7.50
Graphite, Ceylon, lump, bbl., lb.	.07 – .08½	.07 – .08½	.07 – .08½
Gum copal Congo, bags, lb.	.09 – .10	.09 – .10	.09 – .10
Manila, bags, lb.	.09 – .10	.09 – .10	.16 – .17
Damar, Batavia, cases, lb.	.13½– .16	.13½– .16	.15½– .16
Kauri No. 1 cases, lb.	.19 – .25	.19 – .25	.20 – .25
Kieselguhr (f.o.b. N. Y.), ton.	50.00 –55.00	50.00 –55.00	50.00 –55.00
Magnesite, calc, ton.	50.00 –.....	50.00 –.....	50.00 –.....
Pumice stone, lump, bbl., lb.	.05 – .07	.05 – .08	.05 – .07
Imported, casks, lb.	.03 – .40	.03 – .40	.03 – .35
Rosin, H., bbl.	8.00 –.....	7.25 –.....	5.90 –.....
Turpentine, gal.	.42½–.....	.41 –.....	.51 –.....
Shellac, orange, fine, bags, lb.	.25 –.....	.25 –.....	.25 –.....
Bleached, bonedry, bags, lb.	.17½–.....	.18 –.....	.21 –.....
T. N. bags, lb.	.13½–.....	.14½–.....	.14 –.....
Soapstone (f.o.b. Vt.), bags, ton.	10.00 –12.00	10.00 –12.00	10.00 –12.00
Talc, 200 mesh (f.o.b. Vt.), ton.	8.00 – 8.50	8.00 – 8.50	8.00 – 8.50
300 mesh (f.o.b. Ga.), ton.	7.50 –10.00	7.50 –10.00	7.50 –11.00
225 mesh (f.o.b. N. Y.), ton.	13.75 –.....	13.75 –.....	13.75 –.....

INDUSTRIAL NOTES

E. I. DU PONT DE NEMOURS & Co., INC., R. & H. Chemicals Division, Wilmington, Del., has acquired the rights to manufacture and sell the Reid generator from the Cyanide Generator Co., Tacoma, Wash.

GEHNRICH & GEHNRICH has moved its office and plant to 32–32 57th St., Woodside, N. Y.

CHICAGO PNEUMATIC TOOL CO., New York, has appointed W. C. Straub, former manager of the New York office, to the position of assistant to the executive vice-president. A. D. Stern succeeds Mr. Straub as manager.

INTERNATIONAL NICKEL CO. OF CANADA, LTD., on Oct. 22, opened a new research and development laboratory at Birmingham, England. The new laboratory, costing $150,000 becomes part of the research organization which includes a laboratory at Bayonne, N. J., and one now under construction at Copper Cliff, Ont., Canada.

THE BRISTOL CO., Waterbury, Conn., has added four graduate engineers to its field service organization. E. H. Hart has been assigned to the Boston office; J. N. Swarr to the New York office; K. J. Platt to the Philadelphia office; and R. A. Barnes to the St. Louis office.

BABCOCK & WILCOX CO., New York, has appointed H. S. Dershimer as its sales representative in Tulsa, Okla. Dallas, Texas, headquarters of the company are in The Wilson Bldg., with Reid R. Lumsden in charge. O. E. Berg is in charge of the tube company's office at Houston.

WEISBERG & GREENWALD, INC., New York, has changed its name to Louis Weisberg, Inc. Williard F. Greenwald has withdrawn from the corporation.

THE NU-ENAMEL CORP., Cleveland, has acquired the plant of the Chi-Enamel Paint & Varnish Co.

ALSOP ENGINEERING CORP. has moved to a new factory at Milldale, Conn., but retains offices, show rooms and a service department at 17 West 60th St., New York.

New CONSTRUCTION

Where Plants Are Being Built in Process Industries

	Current Projects		Cumulative 1936	
	Proposed Work	Contracts	Proposed Work	Contracts
New England	.....	$124,000	$540,000	$1,253,000
Middle Atlantic	$1,114,000	1,585,000	13,712,000	12,281,000
South	8,190,000	680,000	22,048,000	18,395,000
Middle West	90,000	352,000	10,004,000	8,780,000
West of Mississippi	90,000	125,000	6,713,000	10,406,000
Far West	500,000	367,000	4,690,000	6,149,000
Canada	80,000	280,000	14,405,000	9,034,000
Total	$10,064,000	$3,513,000	$72,112,000	$66,298,000

PROPOSED WORK
BIDS ASKED

Chemical Plant—Atlas Powder Co., Wilmington, Del., plans to construct a large plant in the vicinity of Wilmington for the manufacture of industrial chemicals. Estimated cost $1,000,000.

Distillery—Hildick Distilleries, J. Edgar Jennings, Pres., Lyons, N. Y., plans to construct a factory for the manufacture of apple flakes. Maturity in 1937. Estimated cost $40,000.

Distillery—Miami Springs Distilling Co., W. J. Hicks in charge, Hialeah, Fla., plans to construct a distillery, bottling plant and offices. Estimated cost $100,000.

Factory—Fla-Tex Products Co., Flatonia, Tex., plans to construct a factory to be used for refining Fuller's earth. Estimated cost $40,000.

Factory—Pioneer Flintkote Co., 5500 South Alameda St., Los Angeles, Calif., plans to construct an addition to its factory. Estimated cost will exceed $500,000.

Gas Plant—Allentown-Bethlehem Gas Co., J. A. Frick, Pres., Allentown, Pa., plans to recondition and improve its gas manufacturing plant. Maturity indefinite.

Laboratory—LaMotte Chemical Products Co., McCormick Bldg., Baltimore, Md., plans to construct a chemical laboratory at Lutherville, Md.

Laboratory—State Highway Dept., Bismarck, N. D., will soon receive bids for the construction of a 50x70 ft. testing laboratory. Estimated cost $50,000.

Oil Filter—Standard Oil Co. of Ohio, Midland Bldg., Cleveland, O., is having plans prepared by Arthur C. McKee Co., Engrs. and Contrs., Euclid Ave., Cleveland, for the construction of a filter plant for oil. Estimated cost $50,000.

Paper Mill—Southern Kraft Corp., subsidiary of International Paper & Power Co., 220 East 42 St., New York, N. Y., plans to construct a kraft paper mill at Georgetown, S. C. Estimated cost will exceed $8,000,000.

Powder Factory—Republic Bronze Powder Co., A. H. Gross, Pres., 3000 Woodhill Rd., Cleveland, O., is receiving bids for five factory buildings, 30x121 ft., 20x20 ft., 30x80 ft., 20x40 ft. and 22x25 ft., on Forbes Rd. E. G. Hoefler, 5005 Euclid Ave., Cleveland, Archt. Estimated cost $40,000.

Soap Factory—Austin Becker, Port Rowan, Ont., Can., plans to construct a soap factory and will purchase equipment. Estimated cost $40,000.

Sugar Refinery—Glenwood Cane Sugar Cooperative, Napoleonville, La., is having plans prepared by S. Stone, Jr., Masonic Temple, New Orleans, La., for the construction of a cane sugar refinery. Estimated cost $90,000.

Vinegar Factory—Dominion Vinegar Co., Ltd., c/o Herve Baribeau, Levis, Que., Can., plans to construct a factory on Commercial St. to have an annual capacity of 300,000 gal. Equipment will be purchased. Estimated cost $40,000.

Sulphite Digesters—E. B. Eddy Co., Ltd., Hull, Que., Can., plans to install sulphite digesters.

CONTRACTS AWARDED

Chemical Plant—Royal Manufacturing Co., M. Kovacs in charge, 19 North First St., Duquesne, Pa., has awarded the contract for the construction of a 3 story, 50x120 ft. chemical plant to Pittsburgh Contracting & Engineering Co., 811 Rebecca Ave., Wilkinsburg, Pa.

Chemical Factory—Smith Chemicals, Ltd., Cornwall, Ont., Can., has awarded the contract for the construction of a factory to Anglin-Norcross-Quebec, Ltd., Montreal, Que., Can. Estimated cost $100,000.

Clay Factory—Kaolin, Inc., Spruce Pine, N. C., has awarded the contract for the construction of a clay and kaolin extraction and processing plant in Avery County to H. K. Ferguson Co., Hanna Bldg., Cleveland, O. Estimated cost $40,000.

Enamel Factory—Pittsburgh Plate Glass Co., 235 East Pittsburgh Ave., Milwaukee, Wis., has awarded the contract for the construction of an enameling plant to W. W. Oeflein, Inc., 312 East Wisconsin Ave., Milwaukee.

Factory—Celanese Corporation of America, 180 Madison Ave., New York, N. Y., has awarded the contract for an addition to its factory at Amcelle, Md., to G. F. Hazelwood, Cumberland, Md. $300,000.

Factory—Flintkote Co., East Rutherford, N. J., has awarded the contract for the construction of a 3 story 125x263 ft. factory to Ferber Construction Co., 16 Johnson St., Hackensack, N. J.

Factory—Hoover Color Co., 13 Cordier St., Newark, N. J., has awarded the contract for the construction of a 1 story, 47x76 ft. addition to its factory to F. D. Trainor & Son, Inc., 12 Smith St., Irvington, N. J.

Factory—Linde Air Products Co., 956 Main St., Buffalo, N. Y., has awarded the contract for the construction of a factory on Woodward Ave. and Sheridan Dr., Tonawanda, N. Y., to J. W. Cowper Co., Sidway Bldg., Buffalo. Estimated cost exceeds $1,000,000.

Factory—Paraffine Companies, Inc., Brannan near 4th St., San Francisco, Calif., has awarded the contract for an addition to its factory for the manufacture of linoleum to Barrett & Hilp, 918 Harrison St., San Francisco. $40,000.

Glass Factory—Pittsburgh Plate Glass Co., Charlotte, N. C., has awarded the contract for the construction of a factory at 6th and College Sts., to J. A. Jones Constr. Co., Charlotte. Estimated cost $40,000.

Glass Factory—Pittsburgh Plate Glass Co., 928 South Main St., Los Angeles, Calif., has awarded the contract for three additions to its factory to Rainey & MacIsaac, 6624 Stanford Ave., Los Angeles. Estimated cost will exceed $37,000.

Kiln—Salem China Co., Salem, O., has awarded the contract for a decorating kiln to Allied Engineering Co., 4150 East 56th St., Cleveland, O. Estimated cost $25,000.

Kiln—Standard Sanitary Manufacturing Co., Ltd., 1000 Lansdowne Ave., Toronto, Ont., Can., has awarded the contract for the construction of a kiln building to Milne & Nicholls, 2498 Yonge St., Toronto, Ont. Estimated cost $40,000.

Laboratory—Gulf Refining Co., Gulf Bldg., Pittsburgh, Pa., has awarded the contract for the construction of a 1 and 2 story, 50x250 ft. research laboratory at Harmarville, Allegheny Co., Pa., to Hughes-Foulkrod Co., Koppers Bldg., Pittsburgh, Pa.

Paper Mill—Smith Paper Co., Inc., Mill St., Lee, Mass., has awarded the contract for the construction of a finishing building to D. O'Connell & Sons, Inc., 480 Hampden St., Holyoke, Mass. Estimated cost will exceed $37,000.

Pulp Mill—Grays Harbor Pulp & Paper Co., Hoquiam, Wash., has awarded the contract for an addition to house one digester, screening units, bleaching plant and new filter plant to Austin Co., Dexter Horton Bldg., Seattle. Estimated cost will exceed $40,000.

Powder Factory—U. S. Bronze Powder Works, 220 West 42nd St., New York, N. Y., has awarded the contract for the construction of a 2 and 3 story factory building at Closter, N. J., to Potterton Bros., 215 West 28th St., New York, N. Y. Estimated cost $100,000.

Rayon Mill—American Enka Corp., Enka, N. C., has awarded the contract for foundations for proposed plant addition to Potter & Shackleford, Greenville, S. C., structural steel to Ingalls Iron Works, Birmingham, Ala. Estimated total cost $200,000.

Oil Distilling Factory—Shell Oil Co., Shell Bldg., San Francisco, Calif., has awarded the contract for the construction of a lubricating oil distilling plant to E. B. Badger & Sons, Box 37, Associated, Calif. Estimated cost exceeds $250,000.

Refinery—Chalmette Refining Co., Chalmette, La., has awarded the contract for the construction of a refinery to Arthur G. McKee Co., Euclid Ave., Cleveland, O. Estimated cost $400,000.

Refinery—Ina Oil & Refining Co., c/o G. Tiffany and F. M. Shaver, Milam Bldg., San Antonio, Tex., plans to double the capacity of its refinery at Hondo, Tex. Work will be done by company forces. $45,000.

Refinery—Ohio Oil Co., Medicine Bow, Wyo., is building an oil stabilizing plant. Work has been started by day labor. Estimated cost $80,000.

Roofing Factory—Tilo Roofing Co., 346 Longbrook Ave., Stratford, Conn., has awarded the contract for an addition to its factory to Shaughnessy Construction Co., First Natl. Bank Bldg., Bridgeport, Conn. Estimated cost $50,000.

Roofing Plant—Toronto Asphalt Roofing Mfg. Co., Ltd., Oxford Dr., Mount Dennis, Toronto, Ont., Can., has awarded the contract for the construction of a plant to Dickie Construction Co., Ltd., 17 Yorkville Ave., Toronto, Ont. Estimated cost $40,000.

Rubber Factory—Goodyear Tire & Rubber Co., Akron, O., has acquired the plant at Windsor, Vt., formerly occupied by the National Acme Co. and will improve same for its own use. Work will be done by separate contracts and day labor. Estimated cost exceeds $37,000.

Rubber Factory—Ohio Rubber Co., E. M. Winegar, Supt., Willoughby, O., has awarded the contract for alterations and additions to its factory to G. C. Rutland, Lost Nation Rd., Willoughby. Estimated cost $40,000.

Soap Factory—Colgate-Palmolive-Peet Co., Ltd., Natalie St., Toronto, Ont., Can., has awarded the contract for the construction of an addition to its soap factory to Carter-Halls-Aldinger Co., Ltd., 419 Cherry St., Toronto. Estimated cost $100,000.

Storage Warehouse—Colgate-Palmolive-Peet Co., 105 Hudson St., Jersey City, N. J., has awarded the contract for the construction of a storage warehouse at Jeffersonville, Ind., to J. D. Jennings, 328 East Breckenridge St., Louisville, Ky. Estimated cost $200,000.

Storage Warehouse—Dayton Rubber Co., 2380 West Riverview Ave., Dayton, O., has awarded the contract for the construction of a storage warehouse to Henry Stock & Son, 55 Brandt St., Dayton. Estimated cost $50,000.

Warehouse—Hunter Baltimore Rye Distillery, Inc., 405 West Redwood St., Baltimore, Md., has awarded the contract for the construction of a 6 story warehouse at Gwynnbrook, Md., to G. Walter Tovell, Inc., Eutaw and Morrow St., Baltimore.

Production of Glycerine Shows Slight Gain This Year

THE Bureau of the Census, at the close of last month released figures showing factory production, consumption, and stocks of fats and oils for the quarter ended Sept. 30. In view of the strong price situation which exists in the market for glycerine and the reported scarcity of offerings for spot delivery, the Census data on glycerine are of particular interest. The figures for production are encouraging inasmuch as they indicate that the home output for the nine months of this year was larger than that turned out in the corresponding period of 1935. The rate of increase, however, is so small that it offers very little promise for any material expansion in domestic production for the twelve months. The Jan.-Sept. totals—combining crude, dynamite and chemically pure grades—were 204,732 thousand pounds in 1936 and 202,194 thousand pounds in 1935. As production for the first half of this year was in round numbers 128,400 thousand pounds as against 140,000 thousand pounds for the like period of last year, it is evident that manufacturing operations were speeded up in the third quarter of this year.

The necessity for importing glycerine still exists and with consuming requirements growing steadily larger, an ample supply can be secured only through enlarged home production, enlarged imports or a combination of the two. Imports in the first half of this year were comparatively light but arrivals from abroad in August and September were on a much larger scale bringing the nine month total to 8,377 thousand pounds which exceeds imports for the twelve months of 1935.

Prior to the World War our imports of glycerine ran from 30 million to 40 million pounds a year. Difficulty would be found at present in finding such surplus amounts in foreign countries. The scarcity of glycerine is not confined to the United States. Early in October, the Department of Commerce issued a report from our consul at Frankfort-on-Main. The report stated that a threatened shortage of glycerine in Germany has caused the Government to issue regulations subjecting the entire trade to stricter official control and hereafter this product may be sold in the domestic market only when transactions are approved by the Trade Control Board. This action follows a decree issued in November of last year which prohibited the exportation of glycerine from Germany except in officially approved special cases.

German foreign trade in glycerine is normally characterized by importation of crude and the exportation of the refined product. Imports of crude glyhave likewise declined from 5,331 metric tons in 1932 but since that time a steady decline has been recorded—1,172 tons being brought in during the first half of the current year. Exports of refined have likewise declined from 5,331 metric tons in 1930 to only 712 tons in 1935, but during the first half of 1936 there was a slight increase to 478 tons, official statistics show.

Italy was Germany's principal market for refined glycerine in 1935, taking 479 metric tons against none during the preceding year. The Netherlands, Belgium, Austria, and Great Britain have been the principal source for Germany's imports of crude this year—none coming from Russia which formerly supplied the bulk of the German demand for this product, it was stated.

Development of domestic sources for fatty-acids and glycerine is considered one of the major problems now confronting German chemists and the problem will doubtless receive the closest attention from research laboratories of large German soap and chemical concerns.

If the rate of factory consumption of glycerine, as reported for the first nine months of this year, is carried through the entire twelve months, a total of approximately 187 million pounds will be realized. While this figure is below that in the column for 1929, it is very large when the availability of stocks and the high level of current prices are taken into consideration.

Total consumption of glycerine may be arrived at by taking the figures for domestic production, adding the import quantities, deducting exports, and adjusting warehouse stocks held at the beginning and end of the several years. On that basis, total consumption figures as follows:

Total Domestic Consumption of Glycerine 1927 - 1936

	1000 lb.
1927	259,147
1928	255,294
1929	290,389
1930	273,817
1931	256,340
1932	235,660
1933	253,961
1934	289,316
1935	268,636
1936	292,000*

* Estimated from nine month figures.

In the above tabulation the totals for 1933 and 1934 are somewhat high as no deduction has been made for exports in those years. Export figures for glycerine were not separately reported for those two years.

Prices for glycerine in domestic markets have been largely nominal for a long time, at least as far as the spot market was concerned. Buyers of anything approaching rounds lots not only have had trouble in filling their needs but usually have been forced to pay considerably above the openly quoted prices. More recently asking prices have been advanced in order to bring them more in line with the real trading basis. Values for imported glycerine bear out the reports of advancing prices. Such values are taken from consular invoices with an average price of about 3.8c. a lb. for crude and 6c. a lb. for refined for 1932; 2.9c. a lb. for crude and 6c. a lb. for refined for 1933; 6.9c. a lb. for crude and 9.4c. a lb. for refined for 1934; 7.9c. a lb. for crude and more than 12c. a lb. for refined for 1935; and 8.6c. a lb. for crude and 11.4c. a lb. for the first eight months of 1936.

Production, Factory Consumption, and Stocks of Glycerine

	Production				Imports		Total Domestic Supply	Factory Consumption	Stocks End of Year
	Crude 80 per cent 1000 lb.	Dynamite 1000 lb.	C. P. 1000 lb.	Total 1000 lb.	Crude 1000 lb.	Refined 1000 lb.	1000 lb.	1000 lb.	1000 lb.
1936[1] —	111,629	33,821	59,282	204,732	6,793	1,584	213,109	140,237	30,382[2]
1935 —	141,185	48,685	74,705	264,575	8,221	69	272,865	180,169	37,106
1934 —	153,115	48,553	80,359	282,027	14,901	2,214	299,142	188,857	36,231
1933 —	119,812	45,534	58,585	223,931	6,473	2,776	233,180	159,290	26,405
1932 —	133,919	41,539	63,624	239,082	5,382	2,348	246,812	156,970	49,186
1931 —	140,002	43,366	70,528	253,896	10,133	1,966	265,995	168,721	38,294
1930 —	138,675	50,974	69,654	259,303	10,906	3,177	273,386	187,463	28,967
1929 —	140,080	58,981	66,791	265,852	14,602	5,493	285,947	198,255	30,006
1928 —	130,499	46,622	66,419	243,540	4,579	4,210	252,329	171,625	35,822
1927 —	128,209	49,266	59,126	236,601	14,944	8,295	259,840	165,191	40,839

[1] Figures are for the first three quarters of the year.

[2] Stocks on Sept. 30, 1936.